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SUPPLEMENTAL REMEDIAL INVESTIGATION QUALITY ASSURANCE PROJECT PLAN FOR LIBBY, MONTANA

Prepared by
US Environmental Protection Agency
Region 8
Denver, CO

With Technical Assistance from:
Syracuse Research Corporation
Denver, CO

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APPROVAL PAGE

This Supplemental RI Quality Assurance Project Plan has been prepared by the U.S. Environmental Protection Agency, Region 8, with technical support from Syracuse Research Corporation. Study activities addressed in this Plan are approved without condition.

Jim Christiansen
Remedial Project Manager

6/24/05
Date

For Mary Goldade
Region 8 Superfund Chemist
Project Chemist & Quality Assurance Coordinator

6/24/05
Date

DOCUMENT REVISION LOG

Revision	Date	Primary changes
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

LIST OF ACRONYMS

AHERA	Asbestos Hazardous Emergency Response Act
ASTM	American Society for Testing and Materials
BC	Berman Crump
BNSF	Burlington Northern Santa Fe
CI	Confidence Interval
CV	Coefficient of Variation
DF	Detection Frequency
DL	Detection Limit

Comment: Rectify the dual DL acronyms here and w/in the body of the document.

EPA	Environmental Protection Agency
HEPA	High Efficiency Particulate Air
IRIS	Integrated Risk Information System
ISO	International Organization for Standardization
L	Dust Loading
LA	Libby Asbestos
PCME	Phase Contrast Microscopy Equivalent
PE	Performance Evaluation
PEF	Particulate Emission Factor
PLM	Polarized Light Microscopy
PLM-VE	PLM-Visual Estimation
QAPP	Quality Assurance and Project Plan
RAM	Real-time Particulate Monitors
RI	Remedial Investigation
ROD	Record of Decision
SEM	Scanning Electron Microscopy
SOP	Standard Operating Procedures
SUA	Special Use Areas
TAG	Technical Advisory Group
TAL	Target Analyte List
TEM	Transmission Electron Microscopy
USGS	United States Geological Survey
VAI	Vermiculate Asbestos Insulation
XRD	X-Ray Diffraction

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SUPPLEMENTAL QUALITY ASSURANCE PROJECT PLAN FOR THE SUPERFUND REMEDIAL INVESTIGATION AT LIBBY, MONTANA

A. PROJECT MANAGEMENT

A1. PROJECT/TASK ORGANIZATION

Project Directors

This project is being planned and funded by the U. S. Environmental Protection Agency (EPA), Region 8. The following individuals are the EPA project directors with overall responsibility for the design and conduct of this project, and will be the principal data users:

Jim Christiansen
Senior Remedial Project Manager
U.S. Environmental Protection Agency, Region 8

Peggy Churchill
Remedial Project Manager
U.S. Environmental Protection Agency, Region 8

Aubrey Miller, MD, MPH.
Senior Medical Officer & Toxicologist
U.S. Public Health Service Region 8 and
U.S. Environmental Protection Agency, Region 8

Mary Goldade
Performance Evaluation Study
Regional Superfund Chemist,
U.S. Environmental Protection Agency, Region 8

Project Managers

Overall responsibility for implementation of the tasks specified in this project Plan has been assigned to the U.S. Department of Transportation Volpe Center, working under an inter-agency agreement with the EPA. The following individual is the Volpe Center Project Manager with overall responsibility for ensuring successful performance of the tasks specified in this plan:

Mark Raney
U.S. Department of Transportation
Volpe Center

Responsibility for detailed planning and implementation of sample collection activities called for in this project plan have been assigned to CDM Federal. The following individual is the CDM Field Team Leader:

Dee Warren
Field Team Co-Leader
CDM Federal

Terry Crowell
Field Team Co-Leader
CDM Federal

Ms. Warren and Ms. Crowell have responsibility for ensuring that all field team members are properly briefed and trained with regard to the objectives and requirements of the field sampling activities, and for ensuring that all sampling activities are performed in accord with the plan. Ms. Warren is also responsible for making project managers aware of any potential issues or problems encountered by the field teams, and for working with EPA to find approved solutions to those issues.

Quality Assurance

All Quality Assurance activities associated with the implementation of this plan will be overseen by:

Mary Goldade
Quality Assurance Coordinator
U.S. Environmental Protection Agency, Region 8

Ms. Goldade may assess any aspect of this plan and require response actions as needed, or may delegate assessment responsibility to qualified staff. Day-to-day QA activities will be coordinated through Mark Raney.

A2. PROBLEM DEFINITION AND BACKGROUND

In 2000, the U.S. Environmental Protection Agency Region 8 (EPA) began emergency response cleanup of residential and commercial properties at the Libby Asbestos Superfund Site in Lincoln County, Montana. In May, 2002, EPA published an Action Memorandum Amendment (the "Action Memo") that set forth general requirements and reasons for the emergency response cleanup (EPA 2002). In December 2003, EPA published the Draft Final Action Level and Clearance Criteria Technical Memorandum (the EPA "Tech Memo") (EPA 2003). The EPA Tech Memo presented screening level risk estimates and provided specific information about "action levels" that would be used for determining which properties or situations required an emergency response cleanup. It also provided specific information regarding "clearance criteria" that would be used to determine when such a cleanup was complete. The EPA Tech Memo, along with the Draft Final Response Action Work Plan (CDM 2003), established the specific protocols that currently govern emergency response cleanup of most properties at the Libby Asbestos Superfund Site ("the Site").

Concurrent with emergency response cleanup, and as described in Section X of the EPA Tech Memo, EPA has also continued to investigate and evaluate the nature and extent of contamination at the Site, the magnitude of exposures occurring in Libby, and the efficacy of the emergency response cleanup program. The intent of this ongoing evaluation is to gauge the effectiveness of current cleanup practices and to provide the information necessary to improve cleanup efficiency and to support the establishment of a final cleanup program for the Site. As part of this evaluation, EPA has identified several critical uncertainties and data gaps that require further investigation. This Quality Assurance and Project Plan (QAPP) is a supplement to the existing components to the Remedial Investigation (RI) already underway at the site, and is intended to establish a science-based program for addressing these uncertainties and data gaps. For convenience, this document is referred to as the Supplemental RI QAPP. EPA expects that the knowledge gained from this work, will be coupled with existing information to drive any additional investigations that are needed and support the completion of a comprehensive RI Report and the first Record of Decision (ROD) for the Libby Asbestos Site.

A3. DESCRIPTION OF DATA COLLECTION TASKS

Overview

Table 1 provides a summary of 12 tasks that have been identified to derive additional data needed to help strengthen final decision-making at the site.

The first group of tasks listed in the table (Tasks 1-5) are mainly intended to help improve EPA's ability to evaluate human exposure to asbestos in the home and residential environment. Figure 2 is a conceptual site model for human exposure at the Libby site, and shows where Tasks 1-5 fit into our understanding of the site.

The second group of tasks (6-12) are intended to help evaluate the efficacy and protectiveness of EPA's cleanup activities. Figure 3 is a conceptual model that shows how these tasks fit into EPA's clean-up approach at the site.

Each of these tasks is described in detail below (Section B). For each task, a direct rationale for the data collection is discussed. In most cases, the information derived from the various tasks will be used in a "weight of evidence" approach. For instance, information from Tasks 1, 3, 4, and 5 will all be used to assess the efficacy of the outdoor soil cleanup program, even though the specific goal for each task is different. This approach reduces uncertainty and helps to overcome limitations (analytical or otherwise) of any single data collection task.

A4. DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are statements that define the type, quality, quantity, purpose and use of data to be collected. The design of a study is closely tied to the DQOs, which serve as the basis for important decisions regarding key design features such as the number and location of samples to be collected and the chemical analyses to be performed. In brief, the DQO process typically follows a seven-step procedure, as follows:

1. State the problem that the study is designed to address
2. Identify the decisions to be made with the data obtained
3. Identify the types of data inputs needed to make the decision
4. Define the bounds (in space and time) of the study
5. Define the decision rule which will be used to make decisions
6. Define the acceptable limits on decision errors
7. Optimize the design using information identified in Steps 1-6

Following these seven steps helps ensure that the project plan is carefully thought out and that the data collected will provide sufficient information to support the key decisions which must be made

At this site, there are two major factors to consider in the DQO process:

- What is the number of samples needed to adequately characterize variability in the measurement endpoint (e.g., amount of asbestos in soil, dust or air) and allow estimation of meaningful summary statistics (mean, high end value) of measured values?
- What is the analytical sensitivity required to ensure that the accuracy and precision of the results for any single sample are within acceptable limits?

Sample Number

The number of samples needed to adequately characterize a particular measurement endpoint depends on a number of factors, including a) the average value, b) the variability between different measurements, and c) how close the values are to the decision threshold. However, data are very sparse for most of the variables being investigated in this effort, so data are generally not available to estimate typical values and variability between samples. In addition, in many cases, the data will not be used for decision-making based on a simple statistically-based decision rule, but rather will be used in a professional judgment-based weight of evidence evaluation. For these reasons, formal computations of a required sample number are, with a few exceptions, not possible. In addition, because most of the measurement endpoints are likely to be highly variable, it is considered probable that, if the sample number were estimated in the usual fashion, the result would likely be larger than can practically be achieved. Consequently, decisions about sample number are based on the understanding that, in general, the increase in knowledge per increase in sample number tends to become relatively small for sample sizes larger than about 10-20 (see Figure 1). Consequently, the size of most data sets were selected to include a minimum of 10-20 samples whenever site conditions allowed.

Analytical Sensitivity

For most chemicals, the analytical sensitivity for a particular analyte is limited by instrument properties. However, in the case of asbestos, analytical sensitivity can theoretically be adjusted to any target goal simply by adjusting the amount of sample evaluated by microscopy, although in some cases this may become cost prohibitive. Attachment A to this QAPP provides an analysis of target analytical sensitivities for each type of environmental medium, along with a set of stopping rules.

B. DATA GENERATION AND AQUISITION

This section provides a description of each task, including the sampling and analysis requirements. Most sample collection and analysis activities will be performed in accord with Standard Operating Procedures (SOPs) previously established for the Libby site (see Attachment A-1). SOPs for new activities or methods not provided in previous Libby project documents are included in Attachments A-2 and A-3. Where departures from the SOPs are necessary, they will be documented as 'modifications' using an appropriate modification form and the expected effect of these modifications on the findings will be noted. All sampling activities will be performed by EPA contractors who will wear appropriate personal protective equipment and who will follow health and safety requirements outlined in their respective Health and Safety Plans. All new samples collected during this effort will be designated with the prefix "SQ" to denote the governing document (Supplemental RI QAPP) used in sample collection.

B1. SAMPLING AND ANALYSIS TASKS

Task 1. Estimation of Soil Contribution to Indoor Dust

Exposure to indoor dust that is contaminated with asbestos is a potentially important exposure pathway for residents. This is because people spend most of their lives in their homes and exposure occurs frequently. Indoor dust can be disturbed through a wide range of activities (e.g., cleaning, children playing, etc.) which can cause the dust to become suspended in air where it can be inhaled into the lung.

It is widely understood that outdoor soil contributes to the composition of indoor dust. Soil can be brought indoors through a variety of mechanisms including transport via shoes, clothing, pets, or wind. If outdoor soil is contaminated with asbestos, indoor dust can also become contaminated. In fact, screening level calculations suggest that most of the risk attributable to asbestos-contaminated outdoor soil results from the contribution of the soil to indoor dust (as opposed to breathing outdoor air in the immediate vicinity of contaminated soil disturbed by some activity) (EPA 2003). This is because most people spend considerably more time performing indoor activities than they do performing outdoor activities, especially those that cause significant disturbance of yard soils.

Because of the potential importance of exposure to soil-derived contaminants in dust, it is important to understand the relationship between the concentration of asbestos in outdoor soil and the resultant concentration of asbestos in indoor dust. This relationship is expressed as:

$$C(\text{dust}) = C(\text{soil}) \cdot Ksd$$

where:

C(dust) = concentration of asbestos particles in indoor dust (s/cm^2)
C(soil) = concentration of asbestos structures in soil (s/gram)
Ksd = soil to dust transfer coefficient (g soil / cm^2)

Due to lack of site-specific data on Ksd, EPA used an indirect method for estimating Ksd in the screening level risk calculations presented in the EPA Tech Memo (EPA 2003), as follows:

$$\text{Ksd (g soil/cm}^2\text{)} = \text{ksd} \cdot \text{L}$$

where:

Ksd = mass fraction of soil in dust (g soil/ g dust)
L = dust loading (g dust per cm^2 surface area)

Values of ksd and L were estimated based on information derived from other environmental cleanup sites in the West. Site-specific measurements of Ksd in Libby will help increase confidence in the value of this parameter and hence in risk estimates for exposure to asbestos in indoor dust derived from contaminated outdoor soil.

Analytical Requirements

The direct approach for quantifying Ksd is to measure both C(dust) and C(soil) at a location (e.g., a residence) and calculate the ratio for that location. One limitation to this approach is that it assumes that soil is the only source of asbestos in indoor dust. In cases where other sources exist (e.g., release from indoor vermiculite insulation), the concentration of asbestos in indoor dust will be higher than expected based on soil transport alone, and will yield estimates of Ksd that are too high. One way to address this problem is to create a graph that plots C(dust) vs C(soil) at many different locations[1], and use the slope of the best fit regression line as the estimate of the average value of Ksd. However, it is difficult to estimate the range of variability in Ksd between different homes because the fraction of the variability contributed by non-soil sources is not known.

An alternative approach is to select a non-asbestos chemical marker in soil that is not expected to have any significant source in indoor dust other than soil transport. In this approach, Ksd is calculated as follows:

$$\text{Ksd (g/cm}^2\text{)} = [\text{C(dust) (ug/g)} \cdot \text{mass of dust collected (g)}] / [\text{Area vacuumed (cm}^2\text{)} \cdot \text{C(soil) (ug/g)}]$$

In order to be maximally useful, the chemical marker must be readily detectable in soil (i.e., the detection frequency (DF) must be high), and the detection limit (DL) must be sufficiently low to ensure that if the fraction of soil in dust were on the order of 10% or more, the concentration in a dust sample would also be above the detection limit. That is, the DL for a chemical marker must be 1/10 or less of the average concentration in soil. Ideally, the degree of variability of the markers in soil (as estimated by the coefficient of variation, CV = stdev / mean) should be relatively low, since this will increase the accuracy of the analysis. Preliminary data on the concentration of various potential soil markers in soils from the Libby area used for fill at the

[1] Note that Ksd is expected to vary from location to location, so the results combined across many different locations should be thought of as a distribution rather than a single value.

Libby site are summarized below, along with an evaluation of each potential marker based on the three criteria described above:

DF > 80%
DL/mean ≤ 0.1
CV < 0.4

Chemical	DL (ppm)	DF	DL/Mean	CV	Indicator?
Antimony	2.1	0%	2.0	0.2	NO
Arsenic	0.4	100%	0.1	0.3	YES
Beryllium	0.2	67%	0.8	0.5	NO
Cadmium	0.4	25%	1.5	0.4	NO
Chromium	0.4	100%	0.1	0.4	YES
Copper	0.4	100%	0.03	0.3	YES
Lead	2.1	100%	0.3	0.3	NO
Mercury	0.1	0%	2.0	0.1	NO
Nickel	1.1	100%	0.1	0.4	YES
Selenium	0.9	0%	2.0	0.1	NO
Silver	0.4	0%	2.0	0.1	NO
Thallium	0.5	0%	2.0	0.4	NO
Zinc	2.1	100%	0.1	0.5	YES

As seen, based on the criteria above, the best markers of soil in dust are likely to be arsenic, chromium, copper, nickel, and zinc. Because these data are for fill material and are not based on soils from actual Libby residences, it will be necessary to perform analyses of several residential soil samples for the full Target Analyte List (TAL) [excluding mercury] to confirm the selection of the most appropriate chemical indicators. The TAL metals analysis can be performed by SW-846 Method 6010, SW-846 Method 6020, or CLP ILM05.3 ICP/ICP-MS Combo providing all metals achieve the method detection limits shown in the above table. Once all of the data are collected, it is expected that the best indicator of Ksd at a property will be the average of the value of Ksd for each of these markers, since this will tend to guard against any unreliable results due to the presence of a non-soil source of a marker chemical at a location.

Soil sample preparation for Task 1 will occur in accord with SOP CDM (2004) rev 1 with the following modifications. The soils will be dried and sieved as prescribed in the SOP. However, once the soils are sieved, an aliquot of <u>unground</u> soil will be split and placed into a zip-lock bag for TAL metal analysis. The remaining soil, will then be ground and split in accord with the SOP and then submitted for asbestos testing. CDM will prepare a CSF modification form to document which samples have undergone this preparation procedure.

One potential limitation to this approach is that the ratio of the concentration of the marker to the concentration of asbestos in soil might be altered during transport of soil into indoor dust due to preferential transport of smaller particles compared to larger particles. For example, because asbestos particles are small compared to most soil particles, asbestos particles might be transported in air and by other mechanisms more efficiently than the transport of soil particles. If so, the use of a non-asbestos soil marker might yield an imprecise measure of Ksd. This is not thought to be a major source of error, because the particle size distribution of Libby asbestos (LA) structures in Libby soils appears to be very similar to the LA size distribution observed in

Libby dusts (see Figure 4). However, once sufficient data become available, the potential magnitude of any error introduced by preferential transport will be assessed. In addition, both the soil samples and the dust samples will also be submitted for asbestos analysis depending upon the availability of a soil analytical method of sufficient analytical sensitivity, precision, and accuracy.

Sampling Requirements

In order to be representative, all soil samples should be collected as a composite of 5-10 representative surface soil locations (depending on size of the area). As a general rule of thumb, the number of subsamples in a composite should increase to 10 when the total surface area to be sampled is greater than about a 8'x8'. Soil should be collected in accord with SOP CDM-LIBBY-05 (see Attachment A-1) with modifications to accommodate the increase in subsamples. Because asbestos contamination may be restricted mainly to special use areas (SUAs), and the concentration of chemical markers in SUAs may be somewhat different than for the rest of the yard, one composite will be collected from SUAs within the yard, and a second composite collected from non-SUA areas of the property. These SUA and non-SUA samples will be prepared, analyzed, and maintained separately. Soils will be prepared under SOP CDM (2004) rev 1 without modification.

The dust sample should be a composite of multiple indoor locations, focusing on the main living areas. Because a dust mass of several grams is required for analysis, dust collection will be performed using a high-volume vacuum device such as is described in SOP SRC-DUST-01 (see Attachment A-2). As noted above, the area vacuumed must be large enough that a dust mass of several grams is obtained. In most cases this can be achieved by vacuuming a combined (composite) area on the order of 5-10 ft^2.

Number of Sampling Locations

A priori, it is difficult to estimate the number of locations needed to provide a reliable estimate of the average and high end values of Ksd. At another site in Montana (East Helena), the distribution of dust loading (L, mg dust/cm^2) is approximately lognormal with a mean of 0.4 mg dust/cm^2 and a 90th percentile of 0.9 mg/cm^2. The distribution of ksd (the mass fraction of dust derived from soil) is not known, but for screening purposes, it is assumed it is characterized as a beta distribution (range = 0 to 1) with mean = 0.3 and 95th percentile = 0.6. Based on these two assumed distributions, the uncertainty in Ksd [as estimated from the coefficient of variation (CV) and the 90% confidence interval (CI)] depends on the number of sampling locations (N) as follows:

Uncertainty in Ksd

	CV		90% CI (% Truth)			
N	Mean	90th	Mean		90th	
5	124%	148%	18%	284%	15%	325%
10	88%	85%	29%	244%	26%	251%
20	62%	59%	41%	205%	37%	207%
40	45%	42%	52%	177%	50%	178%

As expected, relative uncertainty decreases as N increases. Based on these screening calculations, the target number of locations to be sampled is a minimum of 20. This is expected to yield an estimate of the mean and the 90th percentile whose maximum error is likely to about 2-fold or less.

Characteristics of Sampling Locations

The value of Ksd is expected to vary between locations for two main reasons: 1) the condition of the yard (bare soil *vs.* intact lawn), and 2) the number of "vectors" (i.e., the number of people, especially children, and the number of pets residing at a location) by which yard soil in brought into the house from outside. Therefore, in order to obtain a representative set of Ksd values, the sampling locations should be stratified into four approximately equal groups as follows:

Yard Condition	Number of Vectors (a)	Fraction of Properties
Good (yard is mainly grass-covered)	≤ 3	25%
	≥ 4	25%
Poor (significant bare areas of soil are present)	≤ 3	25%
	≥ 4	25%

(a) For this project, a "vector" is any person (adult or child) or animal that enters and exits the home on a regular basis

Task 2. Estimation of Indoor Dust K-Factors

Once indoor dust becomes contaminated, whether from outdoor soils or other means, it is important to understand the relationship between the indoor dust and the indoor air in the home. If the relationship can be quantified, measurements of indoor dust concentrations can be used to predict concentrations in air that would result if the dust is disturbed. The concentration of asbestos in indoor air that results from disturbance of asbestos in indoor dust is written as:

$$C(air) = C(dust) \cdot Kda$$

where:

C(air) = Concentration of asbestos in air (s/cc) following disturbance of dust
C(dust) = Concentration of asbestos in dust (s/cm^2)
Kda = Release factor for dust to air (cm^{-1})

In the screening level risk estimates found in the appendix of EPA Tech Memo (EPA 2003), EPA used estimates of Kda based largely upon published values in the scientific literature. Obtaining data that provide site-specific estimates of Kda will provide increased confidence in the value of Kda and increase the accuracy of risk estimates at the site. Two different methods for estimating Kda at the Libby site are described below.

Method 1

The most direct method to estimate Kda is to measure the concentration of LA structures in dust and air at a location, and calculate the ratio:

Kda = C(air) / C(dust)

If the release of asbestos from dust to air were identical for all sizes of asbestos particle, the value of Ksd would not depend on the rules used to count asbestos structures (e.g., International Organization for Standardization (ISO), Asbestos Hazardous Emergency Response Act (AHERA), Phase Contrast Microscopy Equivalent (PCME), Berman-Crump (BC)) in dust and air. However, in Libby, the release of asbestos particles from dust to air appears to be influenced by the particle size, as indicated by data showing that the particle size distribution of LA structures found in air is enriched in larger (longer and thicker) structures than the LA structures found in dust (see Figure 4). Because release from dust to air appear to depend on particle size, the value of Kda depends on which type of counting rules are used to express concentration in air and dust. For the purposes of this effort, Kda is defined as the ratio of risk-based structures in air (either PCME s/cc or BC s/cc) to the number of TEM s/cm^2 in the source dust.

During Phase II investigations at Libby (EPA 2005), EPA collected a number of paired air and dust samples during two types of disturbance scenarios: routine activities by residents (Scenario 1), and active cleaning and dusting activities (Scenario 2). However, these samples were analyzed with an analytical sensitivity that was not adequate to allow reliable estimation of site-specific Kda factors (EPA 2005). Therefore, both the air and dust samples from Phase 2 Scenario 1 (routine activity) and Scenario 2 (active cleaning) will be re-analyzed by Transmission Electron Microscopy (TEM) in accord with the counting rules specified in Attachment E. The purpose of the supplemental analysis is to achieve improved analytical sensitivity, which may allow calculation of meaningful Kda factors from the existing samples. Table 2 lists the samples requiring re-analysis. Attachment B describes the target sensitivities that should be achieved, to the extent feasible.

Method 2

A second method for estimating Kda is to measure the transfer of dust (rather than asbestos) from surfaces to air, and then correct that transfer factor to account for any preferential release of asbestos particles compared to dust particles. This is done as follows:

Kda = kδ · (k2 / k1)

where:

kδ = Surface to air transfer factor for dust (mg dust/cc in air per mg dust/cm^2 on surfaces)
k1 = risk-based structures (e.g., PCME or BC) per total TEM structures in dust
k2 = risk-based structures (e.g., PCME or BC) per total TEM structures in air

The potential advantage of this method compared to Method 1 is that the values of k1 and k2 are already known with good accuracy based on the consolidated set of LA particle size data available in Libby, and the value of kδ can be estimated using real-time particulate monitors (RAM) to estimate dust loading in air, and vacuum samples to estimate dust loading on surfaces (SOP SRC-DUST-01):

$$k\delta = \text{Average dust concentration in air (mg/cc)} / \text{Average dust on surfaces (mg/cm}^2\text{)}$$

Sampling Locations

In concept, measures of dust in air and dust loading on surfaces could be collected at any representative set of homes in Libby. However, it will be valuable if estimates of Kda estimated by Method 2 can be compared to estimates based on Method 1. Therefore, a set of homes will be selected for evaluation by both methods simultaneously. These homes should have dust levels of LA that are at least 1000 s/cm^2 to maximize the probability that results from method 1 will yield reliable estimates of asbestos levels in dust and air.

Because the transfer of dust from surfaces into air is expected to be highly variable, a large number of homes would have to be sampled in order to adequately characterize the full distribution of Kda. However, for the purposes of this initial effort, the number of homes will be limited to 12. It is expected that this will be sufficient to estimate the average transfer factor with reasonable confidence, and will provide preliminary information on the magnitude of the variability in Kda between locations.

Sampling Requirements

For Method 1, sampling requirements include an estimate of the 8-hour average LA concentration in indoor air and an estimate of the average LA concentration in dust. Air samples will be collected over a period of about 8-hours using a stationary air monitor in the main living area of the home, and will also include an approximately 8-hour personal air sample (using a high volume personal air monitor) whenever possible. Dust samples will be composites collected using the microvacuum sampling method from approximately three 100-cm^2 template areas located in the main living space of the house in accord with the standard American Society for Testing and Materials (ASTM) approach.

For Method 2, a real-time dust monitor (RAM) will be used to measure the 8-hour average dust concentration in air (mg/m^3) in the main living area of the home under normal living activities. The types of activities performed, duration of each, and any other observations that may be relevant to the sampling effort should be recorded on the field data sheet. The detection limit for the RAM must be 1 ug/m^3 or less. If the resident in the home is willing, airborne dust may be measured with a personal RAM to provide a more accurate measure of dust levels in the breathing zone of the resident. A high volume dust vacuum will be used to collect a composite dust sample from the same main living areas of the home. The mass of dust must be large enough (1-2 grams) that it can be weighed with reasonable precision (±10 mg). The area vacuumed (cm^2) must also be measured with good accuracy so that dust loading (mg/cm^2) can be reliably calculated. The SOP for collection of dust using the high-volume vacuum device is presented in Attachment A-2. If agreed to by the homeowner, pictures and/or videotaping of the activities should be performed to document the physical characteristics of the residence and the types of activities being performed.

Task 3. Estimation of K-Factors for Outdoor Exposure Scenarios

While screening level risk estimates suggest that the contribution of contaminated outdoor soils to indoor dust is the most important exposure pathway for soil, it is also important to understand the relationship between active disturbance of outdoor soil and the concentration of asbestos in air in the immediate vicinity of the disturbance. If the relationship can be quantified, measurements of asbestos concentration in soil can be used to predict concentrations in air if the soil is disturbed. As above, the relation between the concentration of asbestos in soil and in air that results from the disturbance of the soil is described by a K factor:

$$C(air) = C(soil) \cdot Ksa$$

where:

C(air) = Concentration of asbestos in air (s/cc) following disturbance of dust
C(soil) = Concentration of asbestos in soil (s/g)
Ksa = Release factor for soil to air (g soil/cc)

In the screening level risk estimates found in the appendix of the Tech Memo (EPA 2003), EPA used an estimate of Ksa (this factor was referred to as the Particulate Emission Factor, or PEF, in the Appendix) based on EPA default recommendations for the western United States. Measurements of site-specific values of Ksa for several specific soil disturbance scenarios in Libby will help increase confidence in Ksa values and hence in risk estimates for outdoor exposure scenarios.

<u>Task 3a: Re-Analysis of Existing Samples</u>

During the Phase II project (EPA 2005), limited data were collected on the release of asbestos into outdoor air from active soil disturbance (rototillng a garden). This was referred to as Scenario 4. However, as was the case for Scenarios 1 and 2, the samples of air were not analyzed with sufficient sensitivity to allow reliable characterization of asbestos levels in air. Further, the concentration of asbestos in soil was only available semi-quantitatively (based on Polarized Light Microscopy (PLM)), so no quantitative value of Ksa could be derived (EPA 2005). Therefore, the first part of this task is re-analysis of the air samples and soil sample collected during Scenario 4 to achieve lower detection limits, as described in Attachment B.

The original soil sample (a composite of four sub-locations within the garden) will first be re-analyzed semi-quantitative using PLM-Visual Estimation (PLM-VE), since this method has been refined since these soil samples were originally analyzed. Next, the soil sample will be analyzed using electron microscopy in order to obtain quantitative estimates. EPA Region 8 has been working to develop and test several methods for quantifying low levels of asbestos in soil, but to date no one method has proved to yield results of adequate sensitivity, accuracy and precision to meet the requirements of this task. Thus, preliminary measurements may be obtained using TEM analysis in accord with SOP EPA-LIBBY-03 or Scanning Electron Microscopy (SEM) in accord with a method developed by United States Geological Survey (USGS), but subsequent analyses using an improved method may also be required. Data quality requirements for the analysis of the soil samples are provided in Attachment B. The sample requiring re-analysis is listed in Table 2.

Task 3b: Residential Scenario Sampling

The release of asbestos from soil into outdoor air is expected to be highly variable, depending on the nature and intensity of the soil disturbance, as well as on the condition of the soil (wet vs. dry, lawn-covered vs. bare, etc.). Therefore, in order to estimate human exposure from outdoor activities, estimates of Ksa are needed for a number of additional scenarios besides garden rototilling (see Task 3a, above). Three standardized disturbance scenarios that will be evaluated at multiple locations are described below. All scenario sampling will be performed in general accord with the methods and procedures described in Attachment A-3, with site-specific details and adjustments as specified in this QAPP. All scenario sampling activities will occur in summer when soils are dry (at least 48 hours after the end of the last significant rain event).

Child Playing in Dirt with a Shovel and Bucket

One scenario of potential concern is a child playing in an area of bare dirt. Play activities could span a range of different behaviors, but one realistic activity is shoveling the bare dirt into a bucket with a toy shovel and then pouring the dirt back on the ground. This activity will be performed by an adult sitting on the ground, and the personal air monitor will be positioned at a height intended to represent the breathing zone of a sitting child (about 2 feet above the ground). Refer to Attachment A-3 for additional details.

Raking of Bare Soil

Adults may also be exposed to releases from bare soils under a variety of conditions. For the purposes of this project, the scenario selected for evaluation is disturbance during lawn care activities. In order to simulate a high level of soil disturbance, samples will be collected while the soil is disturbed by raking the soil with a metal leaf rake. The activity will be performed by an adult, and the personal air monitor will be at the breathing level of that adult (about 5-6 feet above the ground). Refer to Attachment A-3 for additional details.

Lawn Mowing

Release of soil particles (and hence asbestos particles) from grass-covered areas of soil is expected to be less compared to releases from bare areas or gardens, but could be significant in some cases. In order to simulate a high level of soil disturbance in grassy areas, samples will be collected while the soil is disturbed by mowing the lawn with a gas-powered rotary lawn mower. This activity will be performed by an adult. However, because children may engage in lawn mowing activities in some cases, the personal air monitor worn at a height expected for the breathing zone of an 8-12 year old child (about 3.5-4.5 feet). Refer to Attachment A-3 for additional details.

Residential Scenario Sampling Locations

Because the value of Ksa is likely to vary from location to location, it is important that each scenario sampling effort span a range of locations and conditions in order to obtain data that represent the range of Ksa factors that may occur. One method for ensuring a range of conditions is to stratify on the basis of asbestos in the soil (as estimated by existing PLM-VE sample results). In addition, it is important to perform measurements at yards where outdoor soil has been cleaned up by EPA to help demonstrate that the cleanup was effective. Based on these goals, the set of locations to be evaluated include the following:

Soil Remediated?	Soil Conc. (PLM-VE)	Scenario		
		Child Shoveling Dirt	Raking Bare Areas	Mowing Grassy Areas
Yes	Clean fill or PLM = Non-Detect	6	6	6
No	Bin A (Non-Detect)	3	3	3
	Bin B1 (<0.2%)	3	3	3
	Bin B2 (0.2-<1%)	3	3	3
	Bin C (≥ 1%)	3	3	3

As seen, for each type of scenario, 3 to 6 locations will be selected for each of the soil conditions, corresponding to a total of 18 groups of sample, including 1 soil composite,1 personal air, and 2 stationary air samples. Based on the results of these original 18 sample sets per scenario, additional samples may be collected for one or more scenarios to strengthen the estimates of Ksa, as needed.

Sampling Requirements

Air

For each scenario sampling event, two stationary air samples will be collected: one placed 20-40 feet upwind of the activity location in an area not impacted by other dust-generating activities, and the other placed within 10 feet of the scenario location in a downwind direction. To investigate the potential magnitude of these exposures, two personal air samples will be collected per worker, one at a high flow rate (about 10 L/min) and one at a lower flow rate (about 3-5 L/min). This is done to ensure that if the first filter becomes overloaded with debris, the second filter will be available. The duration of sample collection will be as long as possible (at least 2 hours) in order to increase representativeness and improve sensitivity, but sampling may be terminated earlier if dust overloading is judged to be a problem. Sampling will occur for a period of at least 2 hours (even if that is longer than the activity would be expected to take). This will help ensure that the sample is representative, and will generate an air volume of about 1200 L, which will help in the achievement of target sensitivities (see Attachment B).

Soil

One composite sample of soil will be collected from each scenario area. This should be composed of 10 grab samples (depending on the size of the area), each collected from a depth of 0-2 inches. Soil should be collected in accord with SOP CDM-LIBBY-05 (see Attachment A-1) with modifications to accommodate the increase in subsamples. The total mass of soil collected should be large enough (2-3 kg total) to support any potential future tests and analyses. The sample should be prepared for microscopic examination as usual (CDM 2004) (see Attachment A-1). In addition, basic soil properties (moisture content, sand/silt/clay content) will be measured.

Analytical Requirements

All soil samples will initially be analyzed semi-quantitatively by PLM-VE (SOP SRC-LIBBY-03 Revision 1) to provide an initial estimate of concentration and ensure that the locations selected for scenario sampling span a range of values (as discussed above).

After PLM-VE analysis, all soil samples will be analyzed by electron microscopy to obtain quantitative estimates of asbestos content. EPA Region 8 has been working to develop and test several methods for quantifying low levels of asbestos in soil, but to date no one method has proved to yield results of adequate sensitivity, accuracy and precision to meet the requirements of this task. Thus, preliminary measurements may be obtained using TEM analysis in accord with SOP EPA-LIBBY-03 or SEM in accord with a method developed by USGS, but subsequent analyses using an improved method may also be required. Target sensitivity for soil is described in Attachment B.

All air samples from these scenario sampling activities will be analyzed by TEM using the counting rules specified in Attachment E. Target sensitivities for short-term scenario samples are described in Attachment B. If samples are too overloaded for direct analysis, indirect TEM analysis will be performed.

Data Recording

All relevant field details regarding each scenario sampling event will be recorded using the field data sheet provided in Attachment D. Representative examples of each type of scenario sampling activity will be documented by videotape recording.

<u>Task 3c: Worker Scenario Sampling</u>

Like residents, workers may be exposed to soil in outdoor air as a result of various types of soil disturbance activities. The potential magnitude of these exposures will be evaluated for two cases, as follows:

Golf Course

Workers at the local golf course may be exposed to asbestos fibers released from soil to air under two main types of activity: lawn mowing and soil aeration. To investigate the potential magnitude of these exposures, two personal air samples will be collected per worker, one at a high flow rate and one at a lower flow rate. This is done to ensure that if the first filter becomes overloaded with debris, the second filter will be available. The duration of sample collection will be as long as possible (up to 8 hours) in order to increase representativeness and improve sensitivity, but sampling may be terminated earlier if dust overloading is judged to be a problem. For this scenario, samples of soil will not be collected and analyzed because a sufficient number of soil samples from the golf course have already be evaluated.

EPA Clean-Up Workers

There is an extensive database of personal air samples for EPA workers engaged in various types of remedial activities in and around Libby, including various soil clean-up actions in the main residential-commercial part of town. All of these samples have been analyzed by PCM to assess if an OSHA standard (STEL = 1 s/cc, TWA = 0.1 s/cc) has been exceeded. For samples associated with disturbance of residential soils, only a few exceedences have occurred. In most cases where an OSHA standard was exceeded, the sample was re-analyzed by TEM, and the result of the TEM analysis was typically lower than the PCM analysis. However, TEM analyses were usually not carried out with sufficient sensitivity to allow reliable quantification of LA fiber concentration in air. Therefore, a set of 35 existing personal air samples from EPA clean-up workers will be re-analyzed by TEM to achieve a lower sensitivity (0.0005 s/cc). The samples will be selected to focus on workers engaged in outdoor soil clean-up activities at residential and commercial locations in the main part of Libby.

Task 4. Detection Limits for Soil Methods

EPA has been working to develop and optimize methods for the analysis of low levels (< 1%) of asbestos in soil. One important attribute of any such method is the method detection limit, which is defined for the Libby site as the concentration in soil that yields a result that is significantly higher than the response for reference soil in a substantial fraction (e.g., 90%) of all samples. To date, EPA's focus has been on developing soil analysis methods based on PLM-VE and TEM. Based on available results to date (see Figure 5), it appears that the PLM-VE method can reliably detect the occurrence of asbestos in soil at a concentration of about 0.2%, but the actual detection limit below this value is not well-defined for either PLM-VE or TEM. Therefore, in order to improve the characterization of the ability of each method to detect asbestos, the current program for method evaluation will be expanded to include a series of Performance Evaluation (PE) soil samples that have added LA concentrations in the range of 0.001%-0.2% by mass. These samples will be prepared by the USGS following methods similar to those used to prepare previous PE samples.

Because a low number of structures have been identified in the reference soil currently used to produce PE samples (about 2E+07 s/g, corresponding to a concentration of about 0.02 %), the new "ultra-low" PE samples will be prepared by USGS using a new reference soil that has essentially no fibrous amphibole structures. This new reference soil has been collected by USGS from a location in Nebraska. Analysis of the soil by XRD will be used to confirm the soil is reasonably similar in mineralogy to Libby soil, and an analysis by SEM will be used to confirm that the frequency of structures that are identified as LA is less than 1E+06 s/gram (this would likely correspond to a concentration of less than 0.001%). The PE samples will be prepared by adding a known mass of LA fibers (the same material as used to prepare previous PE samples) to a known mass of soil. The spiked soil is thoroughly wet-mixed and then dried and ground using a plate grinder set to 250 um thickness. The dried and ground material is then re-mixed and distributed into a series of bottles for shipment to the laboratories.

For each analytical method (TEM, PLM-VE), a series of replicates of each of several different PE concentrations will be sent blind to each of 6 laboratories for analysis by PLM-VE and TEM using the SOPs developed for this study. As noted above, the concentrations (expressed in terms of added LA) will range from zero added LA up to about 0.2% added LA. Exact numbers of replicates and nominal values are not reported here to ensure the nominal concentrations are not accidentally provided to the laboratories (un-blinding them). However, there will be a total of approximately 30 samples analyzed at each concentration. For PLM, a sample will be considered a "detect" if it is assigned to Bin B1, Bin B2, or Bin C. For TEM, any sample in which the observed number of LA structures exceeds the 95% percentile of the expected number of counts due to background loading will be considered a detect.[2] The detection limit will be identified as a concentration that is declared to be a detect in some relatively high fraction (e.g, 90% or more) of all samples. Note that the detection limit defined in this way should not be confused with the Limit of Detection (LOD) or with the quantitation limit.

Task 5. Concentration in Soil that is ND by PLM-VE

At present, the primary method for evaluating soil in Libby is PLM-VE. Because many samples are reported as Bin A (not detected, ND) by this method, it is important to characterize the concentrations of asbestos that may be present in such samples. At present, soil that is ND by PLM-VE is not remediated. Understanding what concentrations may remain after cleanup will help to estimate any future residual risk and help assess the efficacy of the soil cleanup program.

Number of Samples

Because the concentration of asbestos is expected to vary between different soil samples, it is important that a number of samples be collected to characterize the distribution of values which occur. Because the true average and standard deviation for soils that are ND by PLM-VE are not known, it is not possible to perform any *a priori* power calculations to suggest the needed sample size. In the absence of data, the initial sample size is set to 20. Additional samples may be added at a later date, based on the initial results.

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[2] Based on current data, the loading of LA structures on field blanks is sufficiently low that detection of a single LA structure in a typical analysis sample will usually be considered a detect.

Sample Characteristics

The only required characteristic of the soils for this task is that each has been evaluated by PLM-VE and that the result was Bin A (ND). However, in order to ensure that the soils evaluated are representative, the samples should be chosen so that the source locations provide a good spatial coverage of the site. In order to achieve this goal, the community of Libby was divided into a series of zones, and soil samples that were ND by PLM were selected at random from within each zone. The five zones are delineated as follows: 1) downtown, east of California Avenue; 2) downtown, west of California Avenue; 3) the area south of Stimson Lumber; 4) the vermiculite mine and Rainy Creek Road; 5) the screening plant and adjacent area known as the flyway. In addition, targeted samples from several locations were also included, including samples from near the export plant, from Stimson Lumber, and downwind from the mine. These targeted samples were selected because it is suspected that these locations have a greater probability of having been impacted by releases than other locations not as close to known sources.

In summary, the samples for inclusion in this task consist of the following:

Location	Number of Samples
Zone 1 (including Stimson Lumber)	4
Zone 2 (including the export plant)	4
Zone 3	4
Zone 4	4
Zone 5 (including the screening plant and flyway)	4
Total	20

Analytical Requirements

EPA Region 8 has been working to develop and test several methods for quantifying low levels of asbestos in soil, but to date no one method has proved to yield results of adequate sensitivity, accuracy and precision to meet the requirements of this task. Thus, preliminary measurements may be obtained using TEM analysis in accord with SOP EPA-LIBBY-03 or SEM in accord with a method developed by USGS, but subsequent analyses using an improved method may also be required. The target sensitivity for these analyses is described in Attachment B.

Task 6-9. Time Trends in Asbestos Levels in Air and Dust in Remediated Buildings

EPA acknowledges that there are limitations and uncertainties regarding the current residential/commercial cleanup program. As described in Page 14 of the EPA Tech Memo (EPA 2003), the current emergency response cleanup program does not completely eliminate all potential exposure to LA in Libby. When the program was designed, EPA attempted to focus resources on removal of large, accessible sources (such as near-surface soil and vermiculite insulation in attics) and cleanup of clearly contaminated indoor areas were ongoing human exposures were likely. Smaller or less-accessible sources (such as potentially contaminated heater ducts and vermiculite within walls) were sometimes left in place. Carpets were generally left in place. In some cases, portions of homes with dust concentrations less than 5000 s/cm^2 were not cleaned. In essence, EPA made educated risk management assumptions that the residual risk and recontamination resulting from these situations would be small, and that the risk could be effectively mitigated through means other than EPA cleanup.

An important part of EPA's approach at the Libby site is to test these assumptions by collecting data on asbestos levels in air and dust following the completion of clean-up activities at a property. The purpose of this post-cleanup sampling is two-fold: 1) provide additional data on asbestos concentrations in air and dust following clean-up actions, and 2) check for any potential re-contamination or air or dust that might be occurring.

Table 3 summarizes the post-clean up evaluation data that have been collected to date. These data strongly support the conclusion that clean-up actions are effective in reducing asbestos levels in air and dust, and that minimal recontamination is occurring, if any. However, samples have been collected at only one point in time at each location, so it is not possible to judge whether any upward time trends due to recontamination from residual sources might be occurring.

Therefore, the purpose of this task is to collect additional post-cleanup data to further characterize cleanup efficacy and to provide data over an extended time frame.

Sampling Locations

Changes over time that are of interest to EPA include both upward trends (suggesting recontamination from some residual source) and downward trends (suggesting continued removal of residual contamination through routine cleaning, HEPA vacuuming, etc.). Therefore, the locations selected from periodic post-cleanup monitoring will include buildings that contain a range of different types of potential residual sources and removal pathways. Specific categories are summarized below:

> *Task 6*. Investigate the potential that VAI that is contained within an intact structure (e.g., a wall) is serving as an on-going source of release to indoor dust or air.
>
> *Task 7*. Investigate whether dust that contains residual LA (at least 500 s/cm^2) but has been left in place is serving as an important source of asbestos in indoor air
>
> *Task 8*. Investigate whether homes where residents are actively using HEPA vacuums for routine cleaning are tending to have decreased asbestos concentrations in dust over time.
>
> *Task 9*. Investigate if carpets are serving as an important residual source, either due to asbestos within the carpet or beneath the carpet.

The following table summarizes the preferred attributes of the buildings to be monitored, along with the number of locations to be included in the study:

Task	Location Characteristics	Number
6	VAI left in fully enclosed walls	3
7	Residual dust > 500 s/cm^2	3
8	HEPA vacuum used regularly	3
9	Dust > 1000 s/cm^2 in or under carpet	3

Sampling Requirements

At each location selected for post-cleanup time trend monitoring, samples of indoor dust and indoor air (both from stationary samplers and personal air monitors worn by residents) will be collected at time intervals of about 3 months, 9 months and 18 months post cleanup.

All stationary air and dust sampling locations should represent living areas frequently used by the residents, and the sampling locations should be the same for each of the three sequential sampling events. All residents who agree to wear personal air monitors during the sampling event will be provided instructions on what to do when leaving the house, and will be provided an activity log to record what general types of activities are engaged in when in the home.

All air samples (both personal and stationary) will be collected under routine living conditions. The flow rates should be about 8-10 L/min and the collection time should be about 8-10 hours. For air samples associated with Task 9 (importance of carpet as a source), the stationary sample will be placed at a height equivalent to a child sitting on the floor (about 2 feet). All dust vacuum samples will be composites from 3 different locations in the main living area of the house (total area = 300 cm^2) collected using the standard microvacuum method based on ASTM D5755-95 established for used at the site.

Analytical Requirements

All samples of air and dust will be analyzed by TEM using the counting rules specified in Attachment E. Attachment B identifies the target sensitivities for both air and dust analyses.

Data Analysis

The data generated as part of this task will be evaluated in several ways, including the following:

a) Absolute concentration values of LA in air (s/cc) and dust (s/cm^2) will be compared with any previous results from the location, risk-based concentrations (see Attachment B), and current decision-making thresholds (EPA 2003) to help evaluate whether post-cleanup conditions continue to satisfy project objectives.
b) If any samples of air or dust suggest that significant recontamination is occurring, an effort will be made to determine if there is any correlation between the occurrence of these samples and any one or more specific factors for recontamination, such as vermiculite in walls, presence of asbestos under carpets, presence of residual contaminated dust, etc. It is understood that the results of such an evaluation will likely

not be definitive, but would be useful in hypothesis formation and the design of any appropriate follow-up investigations.

c) The data from each residence will be evaluated for time trends in air and dust. It is understood that trend analysis based on three time points has relatively low statistical power, especially if there is relatively high variability between repeat samples. Therefore, the analysis will also seek to combine trend data across the multiple locations to assess whether any general pattern can be detected.

Task 10. Concentration in Dust Under Carpets

Asbestos particles that entered homes in the past may become trapped in a variety of different locations, including within and beneath carpets. To date, EPA has been able to achieve indoor air clearance standards leaving carpets in place, and post-cleanup sampling (summarized in Table 3) suggests that carpets left in place have not significantly re-contaminated living spaces after some time has passed. Thus, asbestos within carpets does not appear to be a major source of concern. However, if a carpet that is contaminated with asbestos is removed, fibers that have accumulated under the carpet could be released to air, potentially causing short-term inhalation exposures of residents or carpet workers, and also potentially causing re-contamination of the home.

At Libby, although many dust samples have been collected from carpeted areas, there are no dust samples specifically designed to investigate asbestos levels under carpets. The purpose of this task is to collect dust samples that will provide information needed to characterize the extent of asbestos contamination in dust below carpets and to make preliminary decisions about the likelihood that carpet removal could be a concern. If it is determined that dust under carpets is a likely source of concern, EPA will collect additional samples and develop a risk management strategy, as needed.

Sampling Locations

The level of asbestos in dust under a carpet is expected to depend on a number of factors, including: a) how long the carpet has been in place, b) the number and magnitude of sources (vectors) that could have contaminated the carpet, and c) the frequency and thoroughness of vacuuming by the resident. Therefore, in order to obtain data that is representative of the community, sampling locations will be stratified as follows:

Age of Carpet (yrs)	Known Vectors[a]	Number of Locations
5-10	No	2
	Yes	2
10-20	No	2
	Yes	2
> 20	No	2
	Yes	2

(a) Vectors are pathways by which asbestos contamination may have reached the carpet, such as former residence of a mine worker, presence of unenclosed indoor vermiculite insulation, remodeling of walls or ceilings with vermiculite insulation, etc.

Note that carpets that have been regularly vacuumed with a HEPA vacuum should not be selected. When possible, samples from high-traffic areas are preferred.

Sampling Requirements

All dust samples from under the carpet will be collected using the standard microvacuum technique based on ASTM D5755-95 established for used at the site. The area vacuumed should consist of 2-6 templates (each 100 cm^2), with the number of areas vacuumed depending on the amount of dust present beneath the carpet (more templates for low dust loading).

Analytical Requirements

All dust samples from beneath carpets will be analyzed by TEM using the counting rules specified in Attachment E. Because exposure to dust under carpets will not be a regular occurrence, the target sensitivity for dust analysis will be 200 s/cm^2.

Task 11. Safety Factor

As described in the EPA Tech Memo (EPA 2003), all homes that undergo indoor cleanup are subject to a clearance test of indoor air before residents reoccupy the property. The clearance test consists of using a leaf-blower to vigorously disturb any dust that remains in the house, and then collecting stationary air samples immediately following the disturbance. A home is declared to be suitable for re-occupation only if 5 of 5 samples are ND by the AHERA counting method. This ensures that the concentration is less than 0.001 s/cc. One of EPA's assumptions is that, if the clearance sample is not above a level of concern, then the levels in air that exist under conditions of routine household activities will be of even lesser concern. That is, the difference in airborne concentration of asbestos between an active leaf-blower scenario (< 0.001 s/cc) and a routine activity scenario is thought to provide a certain margin of safety in decision-making. However, the magnitude of the difference between a clearance sample collected after leaf-blower disturbance and a routine sample collected without leaf-blower disturbance has not been measured. The purpose of this task is to obtain data on the ratio of these two types of measures of asbestos in indoor air.

Sampling Locations

Locations for collection of data to evaluate the magnitude of the "safety factor" will be a subset of 8 homes selected at random from the group of homes that are currently undergoing cleanup and air clearance sampling under the present cleanup program at Libby.

Sampling Requirements

At each location scheduled for clearance sampling (i.e., the air sample is collected immediately following disturbance with a leaf-blower), a routine stationary air sample will be collected 2-3 days later (after dust disturbed by the leaf blower has been allowed to settle). The clearance sample will be collected from the main living area of the home in accord with standard procedures (typically resulting in a sample volume of 1200 L). In addition the residents should remain in the area where the stationary sampler is located for the duration of the sampling. The residents should document the activities they perform over the course of sampling. The routine stationary air sample collected on day 2 or 3 should be collected using a flow rate of 8-10 L/min and should span a time interval of 8-10 hours, resulting in a sample volume of 6000-10000 L. In addition, dust samples will be collected, but will be archived for future analysis, if required. The dust samples will be composites collected using the microvacuum sampling method from approximately three 100-cm^2 template areas located in the main living space of the house. These samples will be analyzed if data from stationary air samples contain LA.

Analytical Requirements

All air samples collected for this task will be analyzed for asbestos by TEM using the counting rules specified in Attachment E. Target analytical sensitivities are specified in Attachment B.

Task 12. Evaluation of Ambient Air

Task 12a. Reanalysis of Existing Stationary Ambient Air Samples

One exposure pathway of potential concern in Libby is inhalation of ambient outdoor air. EPA has collected ambient air samples using stationary air samplers at various locations around Libby, and has analyzed them by TEM. A majority of these samples were non-detect, and the samples that did contain LA were at a relatively low level. While these data are consistent with the conclusion that ambient air is not a major source of asbestos exposure in Libby, the current data are limited by the relatively large fraction of all samples that are non-detects. Therefore, the first part of this task is re-analysis of a selected sub-set of the existing ambient air samples to achieve a lower detection limit and thus, an improved understanding of the actual ambient air concentrations of asbestos around Libby.

The total number of samples to be evaluated for this task is 32. The samples selected for this analysis were chosen to achieve both geographical and temporal representation of Libby ambient air. The locations of existing ambient air samples were plotted onto a Libby map, and "zones" or areas of interest were identified to ensure good geographical distribution of the selected samples. Table 4 lists the samples selected for re-analysis.

Each sample shall be re-analyzed by TEM using the counting rules specified in Attachment E at a target analytical sensitivity of 0.0001 s/cc. A sensitivity of 0.0001 TEM s/cc is about 20- to 50-fold lower than most current analytical results, and will allow for a substantially improved characterization of the true asbestos concentrations in ambient air. For example, the excess risk to a resident from continuous lifetime exposure to 0.0001 TEM s/cc in Libby is about 1E-05 (based on the IRIS risk model) to 3E-05 (based on the Berman Crump risk model).

Task 12b. Re-Analysis of Perimeter Air Samples

Another exposure pathway of potential concern in Libby is release of asbestos to air during site clean-up activities, especially outdoor activities that result in disturbance of contaminated soil or waste material. In order to evaluate this pathway, EPA has collected numerous air samples from around the perimeter of all major outdoor cleanup projects and has analyzed these by TEM. Most of these samples were non-detect for LA, and the samples that did contain LA were generally low in concentration (similar to what was seen in ambient air) (see above). While these data are consistent with the conclusion that engineering controls used for dust suppression are effective in limiting asbestos releases to air at outdoor cleanup projects in Libby, the data are limited by the relatively large fraction of all perimeter samples that are non-detects. Therefore, the second part of this task is re-analysis of a selected sub-set of the existing perimeter air samples to achieve a lower detection limit and thus, an improved understanding of the actual air concentrations of asbestos during site clean-up activities.

Locations where perimeter samples have been collected were stratified according to the extent of earthwork [small (< 1,000 cubic yards) or large (> 1,000 cubic yards)] and the concentration of LA asbestos in the soil (low = less than 1% [Bins B1 or B2]; high = greater than or equal to 1% [Bin C]). Specific locations selected for analysis included residential properties for the small sites, and locations such as the export plant and the flyway for the large sites. Other locations were selected for each category at random, as listed below:

LA Level	Small Sites	Large Sites
Low	3647 Highway 2 S (trace in yard)	Riverside Park (boat ramp) (2% in one sample; <1% or TR in all other areas)
	312 Main Ave (trace in carport area)	2293/2297 Kootenai River Rd (<1% in yard areas)
	341 Parmenter Dr (trace in yard)	102 Mineral Ave - Second Hand Store
	507 E. Lincoln Blvd	Flyway
	610 Michigan Ave	
High	781 Terrace View Rd (5% in garden; 10% in stockpile)	150 Education Way - Libby High School (8% in track area)
	500 Jay Effar Rd (4% in garden)	101 Ski Rd - Libby Middle School (7% in school yard)
	123 Hamann Ave (2-3%)	247 Indian Head Rd - Plummer Elementary (5% in play area; 7% in school yard)
	319 Norman Ave (1-3%)	BNSF
	1573 Kootenai River Rd (1-6%)	303 W. Thomas St - Former Export Facility
		Champion Haul Rd (1% and 5%)

A list of all the perimeter air samples collected from these selected stations was prepared. All samples were collected during the time the activity was occurring. A subset of 20 samples, including both detects and non-detects, were selected at random for reanalysis, with the largest number coming from large areas with high soil concentrations (since these are the locations most likely to have caused a release to perimeter stations):

LA Level in Soil (PLM-VE)	Size of the Remedial project	
	< 1000 cubic yards	> 1000 cubic yards
Low (<1%)	5	5
High (≥1%)	5	5

Table 5 lists the samples selected for reanalysis. As above, each perimeter air sample shall be re-analyzed by TEM using the counting rules specified in Attachment E to achieve an analytical sensitivity of 0.0001 s/cc. This sensitivity is up to 20-50-fold lower than most current analytical results, and will allow for a substantially improved characterization of the true asbestos concentrations in perimeter air.

B2. QUALITY CONTROL

Field-Based Activities

Quality Control samples generated by field sampling teams will consist of: field and lot blanks, co-located samples, and field duplicate samples.

Lot Blank:
Before any cassettes may be used for sampling, the lot must be determined to be LA free. This will be accomplished by sending 5 blanks per lot for TEM analysis using the same analytical method planned for the field samples (Appendix E). Once the lot is confirmed to be LA free, that lot may be placed into use for sampling. This requirement pertains to all air (both stationary and personal) and microvacuum dust samples.

Field Blanks:
Field blanks will be collected as described below. Note that some field blanks may be collected but not analyzed, depending on the frequency that contamination is observed on field blank samples. There is no field blank for soil.

Air Field Blanks:
A field blank for air (both stationary and personal) shall be prepared by removing the sampling cassette from the box, opening the cassette to the air in the area where the investigative samples will be taken, then closing the cassette and packaging for shipment and analysis. With one exception, all field blanks will be collected at a rate of 1 per sampling team per day. One field blank per team will be submitted for analysis, the remaining will be archived. Field blanks collected in conjunction with activity-based scenario sampling required a higher frequency of collection. This is due to the lack of site-specific historical data available for field blanks in for this type of sampling. Field blanks for the activity-based sampling will be collected 1 per activity scenario. Approximately 10% of the total number of field blanks collected for a scenario activity will be analyzed and the remaining archived. The fraction of field blanks selected for analysis should range over the length of the project and over expected soil concentration ranges. All air field blank shall be processed for analysis by direct preparation.

Dust Field Blanks:
For dust, the field blank is collected in the same way as for air, except that it shall be processed for analysis by indirect preparation. The rate of field blanks for dust shall be one per team per day. One field blank per team will be submitted for analysis, the remaining will be archived.

Soil Field Duplicates:
Field duplicates are defined here as splits that are taken after field homogenization of soil. They will be collected in accord with SOP CDM-Libby-05. Field duplicates will be collected for both TAL metals and asbestos testing. The required frequency is 1 field duplicate per 20 samples. This frequency should be meet for both parameters of concern: TAL metals and LA.

Co-located Air Replicates:
Replicate samples for air sampling is not a requirement. However, when feasible, side-by-side air pumping systems (co-located samples) will be placed to gauge the reproducibility of results.

Laboratory-Based Activities

Laboratory-based QC samples for air and dust will include a variety of different sample types as specified in the analytical methods. In addition project-specific QC are performed for TEM which include recount same, recount different, repreparation, and validated analysis. These will be prepared and analyzed at the rates specified in Libby Laboratory Modification LB-000029a (v3).

B3. DATA RECORDING AND MANAGEMENT

All data generated during this project will be recorded using the standard hardcopy and electronic data recording forms that have been prepared for use at the Libby site. All data will be uploaded from the electronic data forms into the Libby 2 database for subsequent evaluation and analysis by qualified data users. Specific details for these standardized processes are outlined in Data Management documentation prepared by Department of Transportation-Volpe Center and CDM Federal.

C. ASSESSMENT AND OVERSIGHT

C1. ASSESSMENT AND RESPONSE ACTIONS

Audits

Assessment of field collection activities and laboratory analyses may be evaluated through unannounced audits by project managers or their delegates. The purpose of the audit activities is to ensure that field collection activities and analytical laboratory procedures are being performed in accord with project requirements, to document any changes, additions or deletions that have occurred during field sampling and analysis, and to identify and implement any corrective actions that may be needed.

Results for all audits performed during this project will be documented and submitted to the EPA project managers. Information in the report will include:

- Type of System Audit (Field, Laboratory, Data Management, etc.)
- Date of audit
- Summary of procedures reviewed
- Results of the review/audit including any non-conformances noted
- Corrective Action Request(s) [CAR], if non-conformance noted
- Date by which CAR must be received with response

Corrective Action Procedures

Two types of corrective actions may result from audits and/or oversight: immediate and long-term. Immediate corrective actions include correcting deficiencies or errors or correcting inadequate procedures. Long-term corrective actions are designed to eliminate the sources of deficiencies or errors. If either type of corrective action is deemed necessary following an audit, each step in the following procedures must be documented:

- Identify the deviation
- Request a corrective action
- Report the problem the EPA project manager
- Review the corrective action response
- Perform a follow-up audit to ensure the deviation is not recurring

C2. REPORTS TO EPA

Data reporting consists of communicating summarized data in a final form. QA for reporting consists of measures intended to avoid or detect human error and to correct identified errors. Such methods include specification of standard reporting formats and contents to reduce data transcription errors. Below are examples of report. These will be prepared as directed by the RPM.

Field Activity Reports: The field team leader will provide periodic reports to EPA management regarding the progress of field sampling activities, including the number of planned samples collected to date, the number of samples remaining, any problems encountered, and recommended solutions to any problems.

Laboratory Reports: All analytical results will be provided by the analytical laboratory using the standardized electronic data reporting sheets provided as part of each SOP.

Study Report: Upon completion of the project, a draft study report will be prepared that includes all of the data collected (presented as an electronic database) as well as tabular and graphical summaries of the data. The report will also provide discussion and interpretation of the data, with regard to the specific goals and objectives of each of the specific tasks contained within the project plan. This report will undergo technical review by USEPA. If necessary, comments to the draft report will be provided to the contractor and a final report will be issued (hardcopy and electronic).

D. DATA VALIDATION AND USABILITY

The process of data review, validation and verification is intended to provide data of known quality. Reviews are performed at the level of the field data collection, field and analytical data entry, data evaluations and are prescribed in various existing project documentation. Additional reviews and/or validations will be carried out if they are deemed necessary or desirable.

D1. RECONCILIATION WITH DATA QUALITY OBJECTIVES

Information obtained each component of this project plan will be evaluated through the Data Quality Assessment (DQA) process to determine if the data obtained are of the correct quality and quantity to support their intended use. The DQA process consists of five steps as summarized below (USEPA 1996, 1998b).

1. Review the DQOs and Sampling Design: DQO outputs will be reviewed to ensure that they are still applicable. The sampling analysis and data collection documentation will also be reviewed for completeness and consistency with DQOs.

2. Conduct a Preliminary Data Review: Data validation reports will be reviewed to identify any limitations associated with the data. Basic statistics will be utilized where applicable and meaningful graphs of the data will be prepared. This information will be used to learn about the structure of the data and to identify patterns, relationships or potential anomalies/outliers.

3. Select the Statistical Test: If applicable, the most appropriate statistical procedure for summarizing and analyzing the data will be selected based on the review of the DQOs, the sampling design and the preliminary data review. Key underlying assumptions will be identified that must hold true for the statistical procedures to be valid.

4. Verify the Assumptions of the Statistical Test: If applicable, the statistical test will be evaluated to determine whether the underlying assumption holds or whether departures from the assumptions are acceptable given the actual data or other information about the study.

5. Draw Conclusions from the Data: Results from statistical tests or other data analysis methods will be reviewed and appropriate conclusion or inferences will be drawn and can range from definitive conclusions made using the generated data to the decision that more data must be gathered to make site decisions.

E. REFERENCES

CDM 2003. Final Draft Response Action Work Plan. Libby Asbestos Project. Libby, Montana. November, 2003.

EPA. 2002. Action Memorandum Amendment for the Time-Critical Removal Action at the Libby Asbestos Site. U.S. Environmental Protection Agency, Region 8. May 2, 2002.

EPA 2003. Libby Asbestos Site, Residential/Commercial Cleanup Action Level And Clearance Criteria Technical Memorandum. Draft Final. U.S. Environmental Protection Agency Region 8. December 15, 2003.

EPA 2005. Phase 2 Study Data Summary Report for Libby, Montana. Environmental Monitoring for Asbestos. Evaluation of Exposure to Airborne Asbestos Fibers During Routine and Special Activities. Report prepared by EPA Region 8, with technical assistance from Syracuse Research Corporation (in preparation).

TABLE 1. LIST OF TASKS FOR THE LIBBY SUPPLEMENTAL DATA COLLECTION EFFORT

			Number of Samples					Collection	Preparation	Analysis			
Task	Description	Sub-Task	Type	New (a)	Existing	Sample Requirements	Location	SOP	SOP	Analyte	Method	SOP	DQO
1	Ksd for Soil to Dust		High vol. dust	20		Bulk; Sieve	1 soil and 1 dust sample from each of 20 homes, stratified by yard cond. and # vectors	SRC-DUST-01	SRC-DUST-01	TAL	ICP-MS	6020	DL < 1/5 average in soil
										LA	TEM	(c, d)	N >=50 or S <= 20
			Soil (SUA)	20		Special Use Area composite; sieve		CDM-LIBBY-05 rev1	CDM (2004) rev1 (e)	TAL	ICP-MS	6020	DL < 1/5 average in soil
									CDM (2004) rev1	LA	TEM	TBD (b, d)	N >= 50 or S < 0.0003%
			Soil (non-SUA)	20		Yard composite; sieve		CDM-LIBBY-05 rev1	CDM (2004) rev1 (e)	TAL	ICP-MS	6020	DL < 1/5 average in soil
									CDM (2004) rev1	LA	TEM	TBD (b, d)	N >= 50 or S < 0.0003%
2	Site-Specific Indoor Dust Kda factors	Reanalysis of Phase 2 Secenario 1 samples (routine activities)	Personal Air		9		See Table 2	--	--	LA	TEM	(c)	N >=50 or S <= 4E-05
			Stationary Air		14			--	--	LA	TEM	(c)	N >=50 or S <= 4E-05
			Microvac. dust		9			--	--	LA	TEM	(c)	N >=50 or S <= 20
		Reanalysis of Phase 2 Secenario 2 samples (active cleaning activities)	Personal Air		28		See Table 2	--	--	LA	TEM	(c)	N >=50 or S <= 4E-05
			Stationary Air		22			--	--	LA	TEM	(c)	N >=50 or S <= 4E-05
			Microvac. dust		8			--	--	LA	TEM	(c)	N >=50 or S <= 20
		Comparison of Method 1 and Method 2 for estimating Kda	Stationary air	12		8-hr average	Homes with indoor dust estimated to be > 1000 LA s/cm^2	ISO 10312	ISO 10312	LA	TEM	(c)	N >=50 or S <= 4E-05
			Personal air	12		8-hr average		ISO 10312	ISO 10312	LA	TEM	(c)	N >=50 or S <= 4E-05
			Microvac. dust	12		300 cm^2		ASTM D5775-95	ASTM D5775-95	LA	TEM	(c)	N >=50 or S <= 20
			RAM	12		8-hr average		--	--	Dust conc	--	--	DL <= 1 ug/m^3
			High vol. dust	12		mass > 1-2 grams		SRC-DUST-01	SRC-DUST-01	Dust mass	Gravimetric	--	+/- 50 mg
3	Outdoor soil K factors	Reanalysis of Phase 2 Secenario 4 samples (rototilling)	Personal Air		2		See Table 2	--	--	LA	TEM	(c)	N >=50 or S <= 1E-03
			Soil		1			--	--	LA	TEM	TBD (b)	N >= 50 or S < 0.0003%
		Residential Scenario sampling (child playing in dirt, mowing grass, raking dirt)	Personal Air	54		Paired air/soil samples for residential; soils not needed for golf course	Paired samples from 18 locations for 3 scenarios	ISO 10312	ISO 10312	LA	TEM	(c)	N >=50 or S <= 1E-03
			Stationary Air	108				ISO 10312	ISO 10312	LA	TEM	(c)	N >=50 or S <= 1E-03
			Soil	54				CDM-LIBBY-05 rev1	CDM (2004) rev1	LA	PLM-VE TEM	SRC-LIBBY-03 TBD (b)	N >= 50 or S < 0.0003%
		Golf course mowing, aeration	Personal Air	4-6		6-8 hr samples	Golf course	ISO 10312	ISO 10312	LA	TEM	(c)	N >=50 or S <= 1E-03
		Re-analysis of EPA worker personal air samples	Personal Air		35	Full period preferred over excursion	Outdoor soil clean-ups in the main area of Libby	ISO 10312	ISO 10312	LA	TEM	(c)	N >=50 or S <= 1E-03
4	Detection Limits for Soil		Soil	150		USGS to prepare using off-site reference soil	multiple levels, multiple replicates per level, 6 labs	CDM-LIBBY-05 rev1	CDM (2004) rev1	LA	PLM-VE TEM	SRC-LIBBY-03 TBD (b)	N >= 50 or S < 0.0003%
5	Conc in ND by PLM-VE		Soil		11	All samples must be Bin A (ND) by PLM-VE	Random locations	CDM-LIBBY-05 rev1	CDM (2004) rev1	LA	TEM	TBD (b)	N >= 50 or S < 0.0003%
6-9	Time trends		Stationary air	36		Collected 3 mos., 9 mos., & 18 mos. post cleanup	12 homes, stratified by exposure factors	ISO 10312	ISO 10312	LA	TEM	(c)	N >=50 or S <= 4E-05
			Personal air	36				ISO 10312	ISO 10312	LA	TEM	(c)	N >=50 or S <= 4E-05
			Microvac. dust	36				ASTM D5775-95	ASTM D5775-95	LA	TEM	(c)	N >=50 or S <= 20
10	Dust under carpets		Microvac. dust	12		Stratified by carpet age and number of vectors		ASTM D5775-95	ASTM D5775-95	LA	TEM	(c)	N >=50 or S <= 200
11	Safety Factor		Stationary air	8		Immediately following leaf blower	Paired values from 8 homes; couple with clearance sampling	ISO 10312	ISO 10312	LA	TEM	(c)	N >=50 or S <= 4E-05
				8		2-3 days after leaf blower disturbance							
12	Ambient and Perimeter Air	Re-analysis of existing ambient air samples	Ambient air		32	From stationary samplers not near any known releases	Selected to provide spatial representativeness	--	--	LA	TEM	(c)	S <= 4E-05 s/cc
		Re-analysis of existing perimeter air samples	Perimeter air		20	From stationary samplers downwind of EPA soil clean-up activities	Stratified to provide a range of project sizes and soil levels	--	--	LA	TEM	(c)	S <= 4E-05 s/cc

(a) If suitable locations can be identified and authorization granted

(b) TBD = To Be Determined; preliminary samples may be analyzed using EPA-LIBBY-03

(c) See Appendix E

(d) Analysis of Task 1 soil and dust for asbestos is contingent upon development of an adequate method for soil

(e) Soil for TAL analysis is prepared as described in CDM(2004) rev 1, except that grinding in the plate griner is omitted (see Text discussion in Section B1, Task 1)

TABLE 2. LIST OF PHASE 2 SAMPLES REQUIRING RE-ANALYSIS

Random Property ID	Scenario 1 (routine)		Scenario 2 (active cleaning)			Scenario 4 (rototilling)	
	Air		Air (during)		Dust (pre)	Air (during)	Soil
	Personal	Stationary	Personal (full)	Stationary		Personal (full)	
J			2-00921	2-00911 2-00912	2-00896		
AA	2-00071	2-00072 2-00073	2-00537 2-00542	2-00524	2-00548		
M	2-00165	2-00166	2-00874 2-00878	2-00867	2-00863		
N	2-00155	2-00156 2-00157			2-00678		
AC	2-00004	2-00005	2-00408 2-00411	2-00398	2-00421		
O	2-00026	2-00027	2-01062 2-01066	2-01055	2-01051		
P			2-00793 2-00797	2-00478	2-00473		
F			2-00379 2-00382	2-00361 2-00362	2-00386		
E (cleaning)			2-00090 2-00091 2-00975 2-00979	2-00098 2-00968	2-00964		
E (beating cushions)			2-01344	2-01341	2-01347 2-01346		
T	2-00001	2-00002 2-00003	2-00443 2-00446	2-00429 2-00430	2-00456		
G	2-00247	2-00248 2-00249	2-00642 2-00646	2-00632 2-00633	2-00627		
X	2-00040	2-00041	2-00273 2-00275	2-00258 2-00828	2-00822		
Y	2-00030	2-00031 2-00032	2-00499 2-00502	2-00485 2-00487	2-00506		
I			2-01231 2-01236	2-01223 2-01224	2-01247 2-01248		
Z						2-01187 2-01191	1-01398

Source: EPA (2005)

TABLE 3. SUMMARY OF EXISTING POST-CLEANUP SAMPLING

Random Location ID	Personal Air (s/cc)		Stationary Air (s/cc)		Dust (s/cm^2)	
	Pre	Post	Pre	Post	Pre	Post
1			<4.78E-03	<7.31E-05		<125
2	6.93E-04	1.49E-04	8.53E-04	<4.93E-05	260	<86
3				<1.54E-04	167	<167
4				1.49E-04	217	<418
5			3.74E-03	<7.29E-05	1087	<359
6	5.83E-03		3.54E-04	<3.01E-04	1182	<314
7	1.30E-03	<1.47E-04	1.57E-03	<1.49E-04		<314
8	<3.56E-04		<1.79E-04	<7.42E-05	73	<251
9	5.13E-04		<2.29E-04	<4.89E-05	<191	<125
10			<1.67E-04	<7.44E-05	<274	<125
11			<4.10E-03	<7.37E-05	5095	<314
12			8.11E-04	<4.94E-05	<732	<167
13		<7.48E-05		7.31E-05	<54	<415
14			<2.00E-04	<7.34E-05	<56	<251
15			1.08E-03	<4.93E-05	32	<209
16			<4.63E-03	<7.34E-05	1108	<314
17			<4.73E-03	7.50E-05	479	<251
18			<1.10E-04	<1.48E-04	189	<251
19		<7.67E-04	<2.25E-03	<5.78E-04	1829	<251
20			<2.22E-04	<5.78E-05	274	<251
21	5.75E+00		<4.78E-04	<2.19E-04	2927	<418
22			<4.90E-03	<1.40E-04	1272	<314
23			1.17E-04	<1.49E-04	<67	<125
24			<4.65E-03	<6.64E-04		<251
25		<1.07E-04	1.43E-04	<4.13E-05	<146	<502
26			<9.16E-04	<7.39E-05		<418
27			3.10E-03	<6.56E-04		<251
28	<9.31E-02			<1.46E-04	<146	<314
29			<4.28E-03	<4.95E-05		<209
30			5.46E-04	<2.35E-04	33	<209
31			7.08E-04	<6.62E-04	<146	<314

Pre-cleanup results based on indoor air and dust samples in the Libby 2 database where the Phase description is not identified as “Clean-up Evaluation” (excludes Phase 2 active scenario-related samples). Post-cleanup results based on air and dust samples in the Libby 2 database where the Phase description is identified as “Clean-up Evaluation”. Based on a Libby 2 database download on 12/27/04. Concentrations presented are the “pooled” TEM Total LA values (pooled across multiple analyses and samples for a property). Pooled concentrations are calculated by dividing the total number of structures observed by the total amount evaluated (cc for air or cm^2 for dust) across analyses. If no structures were observed, values are presented as less than the pooled sensitivity.

TABLE 4. LIST OF AMBIENT AIR SAMPLES SELECTED FOR REANALYSIS

Index	Zone	YEAR	Sample ID
1	1	2000	1R-00177
2	1	2000	1-00808
3	1	2000	1-01758
4	1	2001	1A-00010
5	1	2001	1A-00042
6	1	2001	1A-00019
7	1	2002	1-06894
8	1	2002	SL-00168
9	1	2002	1A-00046
10	1	2002	1R-14642
11	1	2002	1R-16562
12	2	2000	1-01308
13	2	2000	1-00809
14	2	2000	1-01757
15	2	2000	1R-00153
16	2	2001	1-03059
17	2	2001	1R-05947
18	2	2001	1R-05948
19	2	2001	1R-07542
20	2	2001	1R-07543
21	2	2002	1R-14272
22	2	2002	1R-17015
23	2	2002	1R-15915
24	2	2002	1R-15937
25	3	2000	1-01755
26	3	2000	1-01759
27	3	2000	1-01457
28	3	2001	1R-06009
29	3	2001	2-01182
30	3	2002	1R-15938
31	3	2002	1R-17005
32	3	2002	1R-14708

Zones	
1	downtown, east of California
2	downtown, west of California
3	area south of Stimson Lumber

TABLE 5. LIST OF PERIMETER AIR SAMPLES SELECTED FOR RE-ANALYSIS

Index	Soil Level	Site Size	Index ID	Location	Prior Result
1	Low	Small	1R-21709	3647 Highway 2 S	Detect
2	(<1%)	(<1000 cy)	1R-21721	3647 Highway 2 S	ND
3			1R-23326	312 Main Ave	ND
4			1R-23353	312 Main Ave	ND
5			1R-20293	341 Parmenter Dr	ND
6			1R-20329	341 Parmenter Dr	ND
7			1R-20474	341 Parmenter Dr	ND
8			1R-23918	507 E. Lincoln Blvd	ND
9			1R-23932	507 E. Lincoln Blvd	ND
10			1R-25265	610 Michigan Ave	ND
11	High	Small	1R-14948	781 Terrace View Rd	ND
12	(>1%)	(<1000 cy)	1R-14967	781 Terrace View Rd	ND
13			1R-14423	500 Jay Effar Rd	ND
14			1R-14613	500 Jay Effar Rd	ND
15			1R-15255	123 Hamann Ave	Detect
16			1R-15264	123 Hamann Ave	ND
17			1R-15326	319 Norman Ave	ND
18			1R-15481	319 Norman Ave	ND
19			1R-22419	1573 Kootenai River Rd	ND
20			1R-22518	1573 Kootenai River Rd	Detect
21	Low	Large	1R-23135	Riverside Park	ND
22	(<1%)	(>1000 cy)	1R-23669	Riverside Park	ND
23			1R-24103	Riverside Park	ND
24			1R-21042	2293 Kootenai River Rd	Detect
25			1R-21225	2293 Kootenai River Rd	ND
26			1R-21269	2293 Kootenai River Rd	ND
27			1R-23944	102 Mineral Ave - Second Hand Store	ND
28			1R-23968	102 Mineral Ave - Second Hand Store	ND
29			1R-25578	KDC Flyway	ND
30			1R-25775	KDC Flyway	ND
31	High	Large	1R-08094	101 Ski Rd - Libby Middle School	ND
32	(>1%)	(>1000 cy)	1R-08610	101 Ski Rd - Libby Middle School	Detect
33			1R-05992	247 Indian Head Rd - Plummer Elementary School	Detect
34			1R-16301	247 Indian Head Rd - Plummer Elementary School	ND
35			BN-00441	BNSF Libby Railyard	ND
36			1R-10837	303 W. Thomas St - former Export Plant	Detect
37			1R-14777	Champion Haul Rd	ND
38			1R-06643	150 Education Way - Libby High School	Detect
39			1R-06860	150 Education Way - Libby High School	ND
40			1R-07078	101 Ski Rd - Libby Middle School	ND
41			1R-08963	101 Ski Rd - Libby Middle School	Detect
42			1R-05964	247 Indian Head Rd - Plummer Elementary School	ND
43			1R-06211	247 Indian Head Rd - Plummer Elementary School	ND
44			1R-10157	303 W. Thomas St - former Export Plant	ND
45			1R-12730	303 W. Thomas St - former Export Plant	ND

FIGURE 1. RELATION BETWEEN SAMPLE NUMBER AND UNCERTAINTY
(ASSUMING A LOGNORMAL DISTRIBUTION)

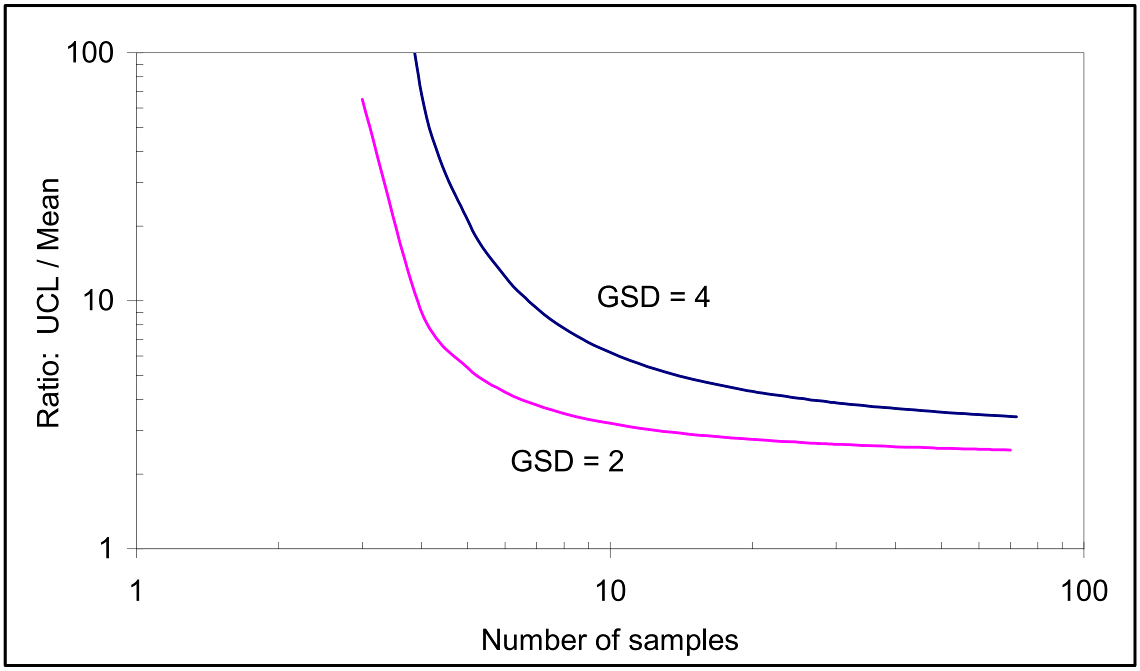


FIGURE 2. SITE CONCEPTUAL MODEL OF HUMAN EXPOSURE PATHWAYS

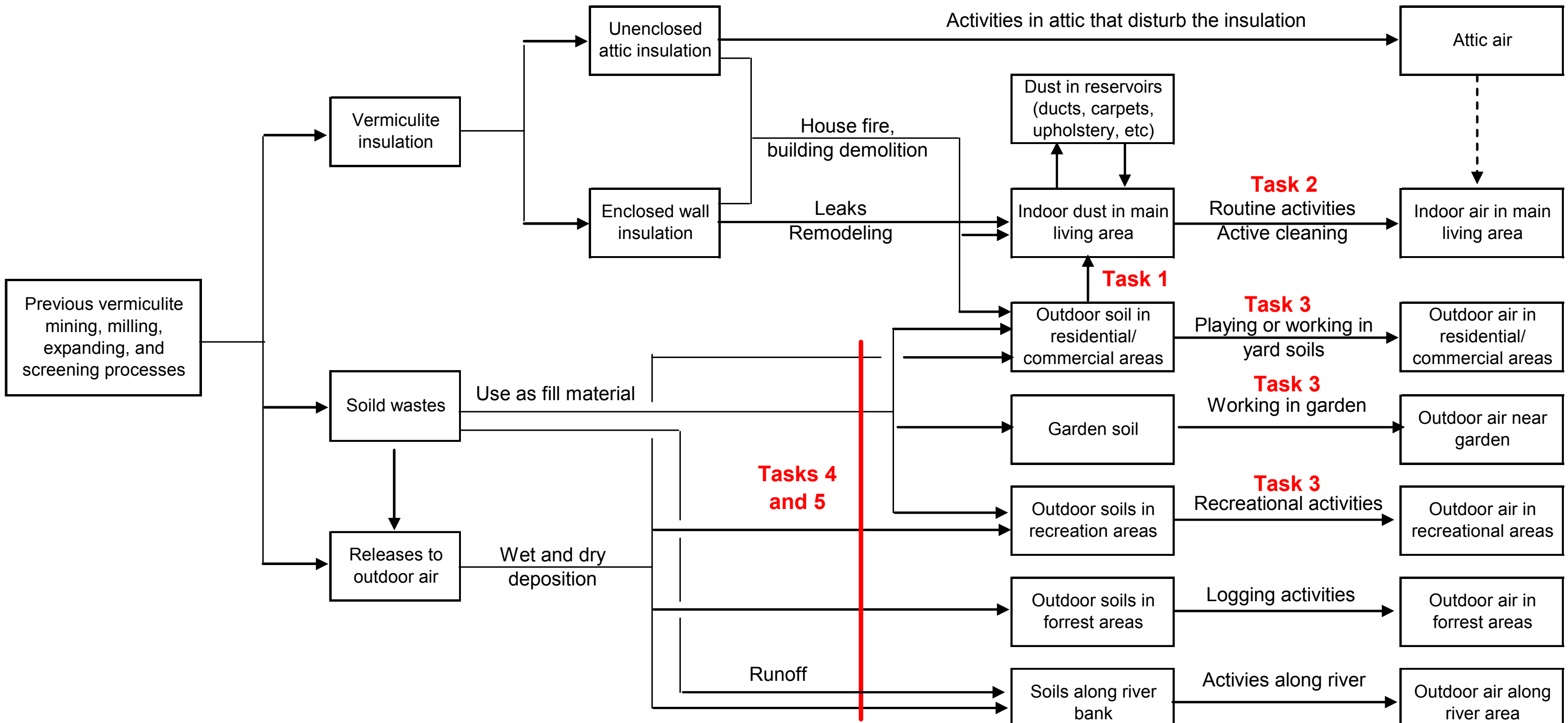


FIGURE 3. EVALUATION OF CLEANUP ACTIONS IN LIBBY

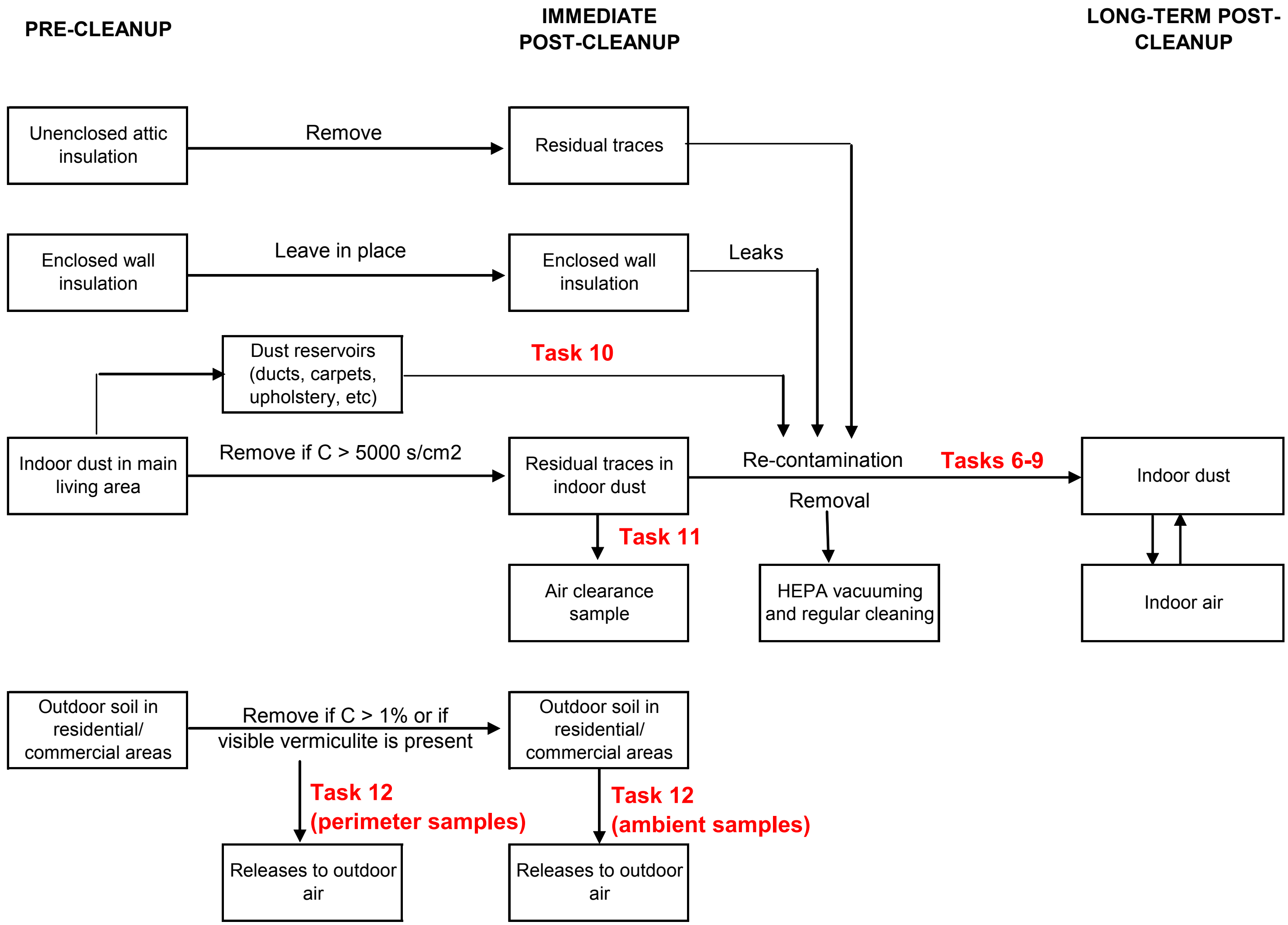
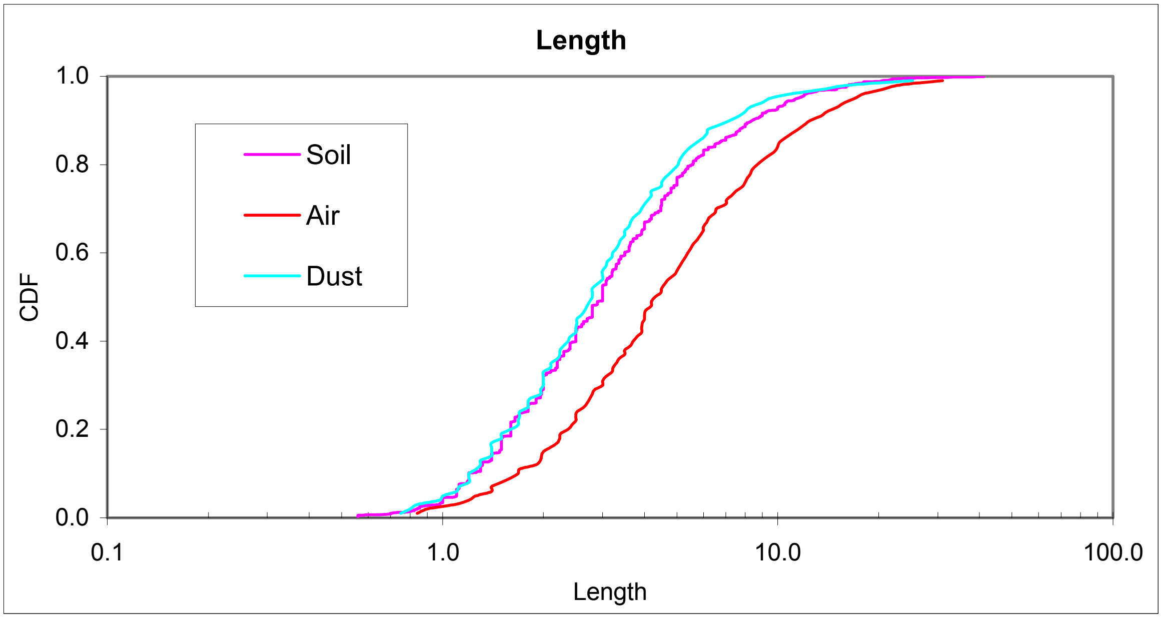
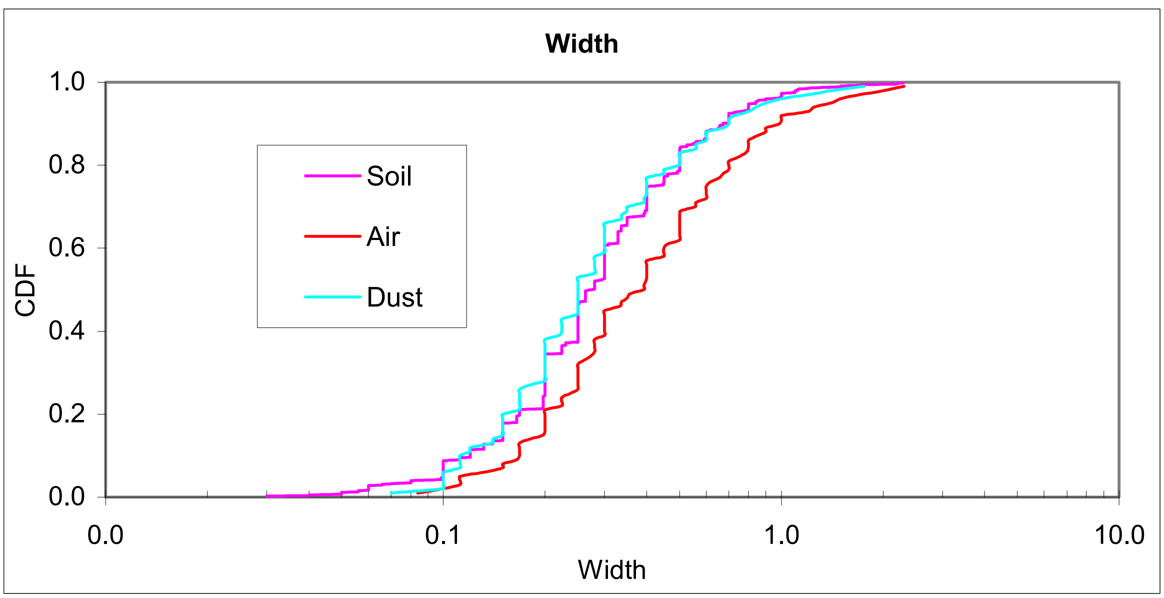


FIGURE 4. LA PARTICLE SIZE DISTRIBUTIONS IN SOIL, DUST AND AIR



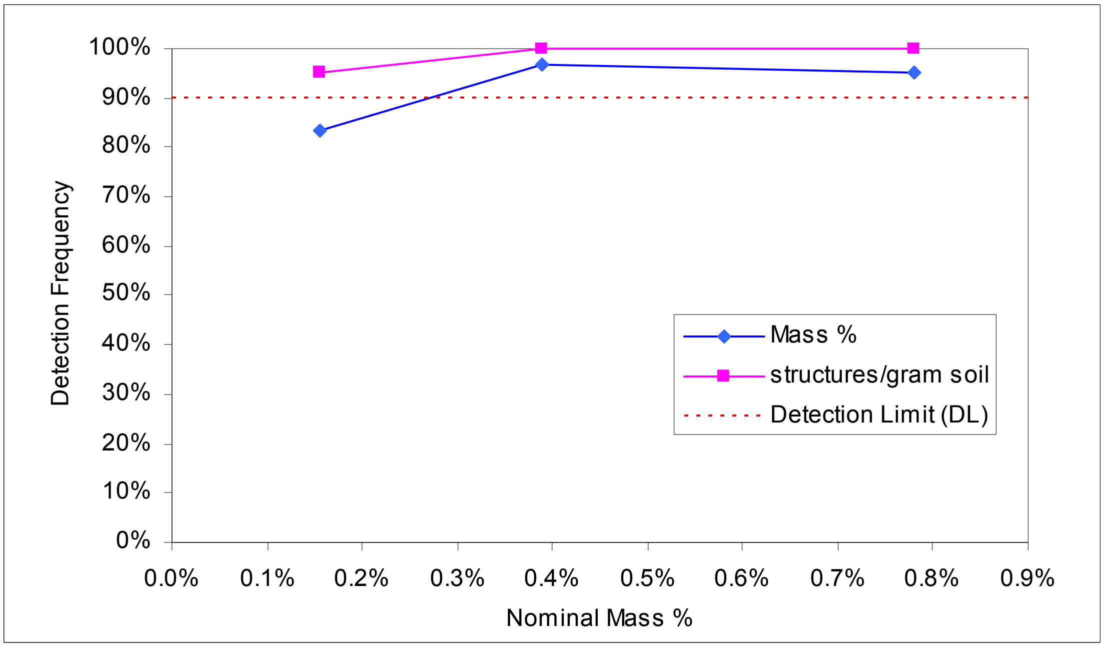


CDF = Cumulative Distribution Function

Soil CDF based on Quality Control (QC) samples analyzed by TEM EPA-600 (N = 883 LA structures). Air and dust CDFs based on analytical results for Libby field samples analyzed by TEM-ISO 10312, TEM-AHERA, or ASTM (N = 7,437 countable LA structures for air; N = 1,796 countable LA structures for dust). Based on a Libby 2 database download on 12/27/04.

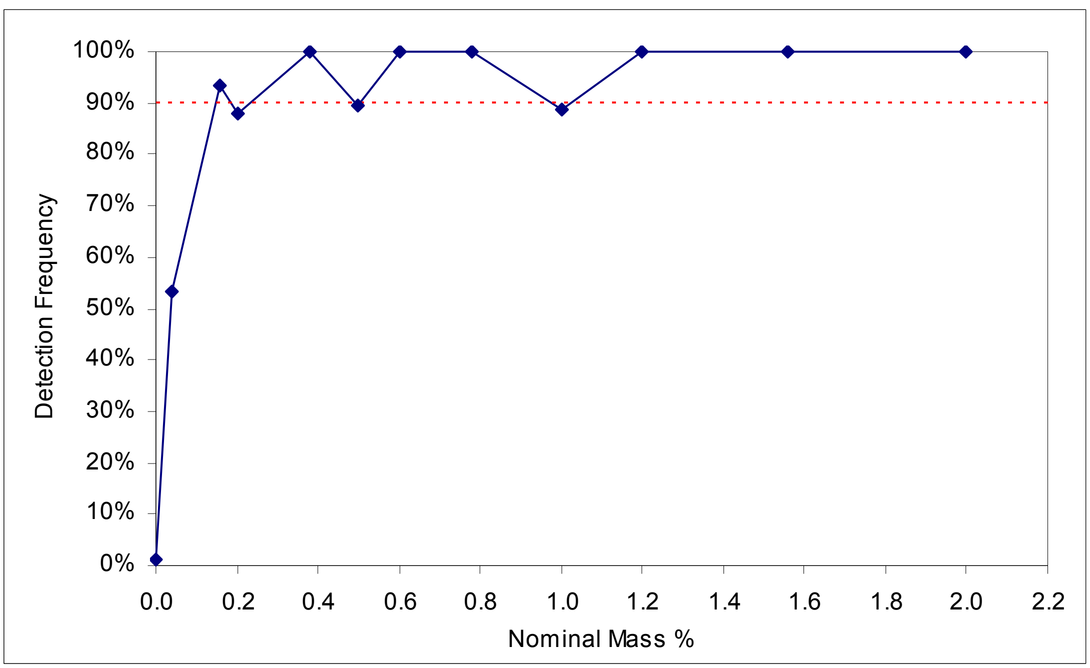
FIGURE 5. DETECTION FREQENCY FOR PLM AND TEM METHODS IN SOIL

Panel A: TEM (EPA 600)



Data derived from on-going Performance Evaluation studies at the Libby site. A sample is ranked as a detect by TLM if any LA structure was noted in the sample.

Panel B: PLM-VE



Data derived from on-going Performance Evaluation studies at the Libby site. A sample is ranked as a detect by PLM-VE if any LA was noted in the sample (Bin B1, B2 or C).

ATTACHMENT A

STANDARD METHODS AND PROCEDURES

ATTACHMENT A-1
LIST OF STANDARD OPERATING PROCEDURES USED PREVIOUSLY

All SOPs listed below are available in CDM (2003): Final Sampling and Analysis Plan, Remedial Investigation, Libby Asbestos Site, Operable Unit 4. May. (Appendices C and E)

CDM SOP 1-2: Sample Custody, with project specific modifications (5/19/03).

CDM SOP 2-1: Packaging and Shipping of Environmental Samples, with project specific modifications (5/19/03).

CDM SOP 2-2: Guide to Handling Investigation-Derived Waste, with project specific modifications (5/19/03).

CDM SOP 4-1: Field Logbook Content and Control, with project specific modifications (5/19/03).

CDM SOP 4-2: Photographic Documentation of Field Activities, with project specific modifications (5/19/03).

CDM SOP 4-5: Field Equipment Decontamination of Nonradioactive Sites, with project specific modifications (5/19/03).

CDM-LIBBY-03 Revision 1: Completion of Field Sample Data Sheets (FSDS)

CDM-LIBBY-06: Completion of Additional Information Field Form (AIFF)

CDM-LIBBY-05 Revision 1: Soil Sample Collection
CDM-LIBBY-08: eLASTIC eCOC Module

ASTM Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Concentrations. Designation Method D5755-95.

CDM 2004. Close Support Facility, Soil Preparation Plan (Revision No. 1), Libby Montanan Asbestos Project Sample Processing. March

OTHER SOPS USED AT THE SITE

SOP EPA-LIBBY-03 (Rev. 2). Analysis Of Asbestos In Soil By TEM

SOP SRC-LIBBY-03 (Revision 1). Analysis Of Asbestos Fibers In Soil By Polarized Light Microscopy

ATTACHMENT A-2
STANDARD OPERATING PROCEDURES NOT USED PREVIOUSLY

SOP SRC-DUST-01. High Volume Indoor Dust Sampling At Residences For Determination Of Risk-Based Exposure To Metals.

ATTACHMENT A-3

ADDENDUM TO THE SUPPLEMENTAL RI QUALITY ASSURANCE PROJECT PLAN FOR THE SUPERFUND REMEDIAL INVESTIGATION AT LIBBY, MONTANA

Activity-Based Air Sampling

The following criteria provide a general description of the methods and approaches for collection of activity-based samples for evaluation of asbestos release from soil into air. Project-specific changes or requirements are specified in the main text of the Supplemental RI QAPP.

For all activity-based sampling events, asbestos samples will be collected from the breathing zones (4 to 6 feet above the work surface for adult scenarios and 1 to 2 feet for a seated child scenario and 3-4 feet for a standing child scenario) of the event participants. Specific breathing zone heights should be determined on a project-by-project basis based on anthropometrics for the study population and the position in which they will be performing tasks. The breathing zone can be visualized as a hemisphere approximately 6 to 9 inches around an individuals face. Breathing zone samples provide the best approximation of the concentration of contaminants in the air an individual is actually breathing.

Samples should be collected at a flow rate of between 1 and 12 liters per minute (L/min) for between 30 and 480 minutes for a target volume of between 40 and 5800 liters (L). Sample volumes and detection/quantification limits should be specified in the site specific Project Plan and flow rates and sampling periods adjusted accordingly. For all asbestos sampling, an asbestos sampling train consisting of 0.8-micron (µm), 25-millimeter (mm) mixed cellulose ester (MCE) filter connected to a sampling pump will be used. The top cover from the cowl extension on the sampling cassette shall be removed ("open-face") and the cassette oriented face down for all asbestos filters. As indicated, all samples shall be collected open-faced unless a specific requirement for sampling closed-faced exists.

Generally each activity based sampling event should be repeated a minimum of three times in an area to expose trends.

Real-time dust measurements should be collected with a dust monitor (DataRam or similar unit) placed as close to the activity as practical without interfering with the activity. Results from dust monitoring may be used for estimating cassette loading factors and possible use in dust emissions modeling. The detection limit for the RAM must be 1 ug/m^3 or less.

A meteorological weather station shall be deployed to record parameters representative of the study area. The following parameters should be measured: wind speed, wind direction, relative humidity, temperature, and barometric pressure. The meteorological station should be of sufficient quality to meet project specific objectives.

A videotape should generally be prepared to record a representative example of each scenario, as well as to document any special conditions or circumstances that arise during the activity.

U.S. EPA ERT has developed general Standard Operating Procedures (SOPs) for sample collection associated with activity based sampling events. This includes: General Air Sampling Guidelines #2008, Met One Remote Meteorological Station #2129 and Asbestos Sampling #2015. These general SOPs should be supplemented with or replaced by site-specific SOPS as needed to provide adequate detail and direction to field sampling teams.

Scenarios

Child Playing in the Dirt

During these events, all personnel will don appropriate personal protective equipment (PPE) and sampling pump(s) while mimicking a child digging or playing in the dirt.

Determine a sampling period and flow rate to collect a sufficient volume of air to achieve the project specific detection/quantification limit. Divide the sampling period into equal sub-periods in order to facilitate having the participant face each compass direction for an equal amount of time during the activity. This approach is designed to mitigate the effect of wind direction on potential exposure. Random head and body movement during the activity should further mitigate the impact of wind direction on exposure. Ideally, the participants will face each compass direction at least twice during the sampling event. For example, given a two hour or 120 minute event, the participant might face North for 15 minutes, rotate to the East for 15 minutes, then South for 15 minutes, then West for 15 minutes and return to the North to repeat the cycle. Participants should move to a fresh patch of soil after the completion of each cycle (360 degree rotation).

In this activity or simulation a participant should dig or scrape the top 1 to 2 inches of surface soil and place it in a small bucket or pail and dump it back on the ground. The activity will be paced such that soil will be placed in the bucket and dumped approximately every 5 minutes, regardless of the amount of material in the bucket. The bucket should be dumped rapidly from a height of approximately 12 inches (based on observations of 2 to 4 year olds playing in a sandbox)

The event participant will be fitted with a personal sampling pump; the inlet to the filter will be at a height of approximately 1 to 3 feet above the ground to simulate a child's breathing zone. The specific height for sample collection should be based on site specific data regarding the height of the population of interest. The actual pump unit should be secured in a backpack or on a belt.

If it is necessary to relieve a participant from the activity, a backup participant will be suited and ready prior to the exchange. The participant will stop the activity, remove the backpack or belt, and pass it to the relief participant similar to the transfer of a baton in a relay race. The original participant will assist the relief participant with donning and adjusting the backpack or belt. The exchange is anticipated to take less than 60 seconds, so the sampling pumps and event time clock will not be halted during the exchange. If the exchange requires more than 60 seconds, the pump and event clock will be stopped until activity is re-initiated.

Raking (Metal Garden Rake)

During these events, all personnel will don appropriate personal protective equipment (PPE) and sampling pump(s) while simulating an adult raking soil debris.

Determine a sampling period and flow rate to collect a sufficient volume of air to achieve the project specific detection/quantification limit. Divide the sampling period into equal sub-periods in order to facilitate having the participant face each compass direction for an equal amount of time during the activity. This approach is designed to mitigate the effect of wind direction on potential exposure. Random head and body movement during the activity should further mitigate the impact of wind direction on exposure. Ideally, the participants will face each compass direction at least twice during the sampling event. Participants should move to a fresh patch of soil after the completion of each cycle (360 degree rotation)

In this activity or simulation a participant should rake a lawn or garden area to remove debris such as rocks, leaves, thatch, weeds, etc. Personnel will use a steel garden rake with a width of approximately 15 inches. Raking will occur in a measured area with vegetation, soil or rocks/gravel. Participants should strive to disturb the top 2 inches of soil (this depth will vary based on the objective of the scenario) with an aggressive raking motion. Raking will occur in an arched motion raking from the left of the participant to the right. The participants will rake the debris in an approximately 120-degree arc towards themselves into a small pile. Once the arc has been sufficiently raked (a reasonable amount of debris collected) the participant will turn 90 degrees clockwise and begin a new arc. There should be some overlap between the arcs. Participants will continue to rake an arc and rotate 90 degrees. Once several small piles of debris have been collected, the participant shall pick up the debris and place it into a trash can. The sequence of raking, rotating and picking up debris shall be repeated for the duration of the sampling period. Participants shall move to a fresh location within the study area upon completion of each set (360 degrees) of arcs.

The raking participants will be fitted with a personal sampling pump contained in a backpack or attached to their belts with the cassettes secured near the operator's lapels in the breathing zone.

If it is necessary to relieve a participant from the activity, a backup participant will be suited and ready prior to the exchange. The participant will stop the activity, remove the backpack or belt, and pass it to the relief participant similar to the transfer of a baton in a relay race. The original participant will assist the relief participant with donning and adjusting the backpack or belt. The exchange is anticipated to take less than 60 seconds, so the sampling pumps and event time clock will not be halted during the exchange. If the exchange requires more than 60 seconds, the pump and event clock will be stopped until activity is re-initiated.

Lawn Mowing (Side Discharge Power Mower)

During these events, all personnel will don appropriate personal protective equipment (PPE) and sampling pump(s) while simulating an adult cutting the lawn.

Determine a sampling period and flow rate to collect a sufficient volume of air to achieve the project specific detection/quantification limit.

In this activity or simulation a participant should operate a gas-powered lawn mower to cut the grass. The lawn mower shall be a 21 to 22 inch side discharge mower rated between 4 and 5 horsepower. Lawn mowing will occur in a measured area with thick vegetation. Mowing will occur in a shrinking square pattern. That is, participants will divide the area into a number of squares that decrease in size towards the center of the square by the width of the mower swath. Mower blades will be set at approximately 2 to 2.5 inches. .

The lawn-mowing participants will be fitted with a personal sampling pump contained in a backpack or belt with the cassettes secured near the operator's lapels in the breathing zone.

If it is necessary to relieve a participant from the activity, a backup participant will be suited and ready prior to the exchange. The participant will stop the activity, remove the backpack or belt, and pass it to the relief participant similar to the transfer of a baton in a relay race. The original participant will assist the relief participant with donning and adjusting the backpack or belt. The exchange is anticipated to take less than 60 seconds, so the sampling pumps and event time clock will not be halted during the exchange. If the exchange requires more than 60 seconds, the pump and event clock will be stopped until activity is re-initiated.

ATTACHMENT B

DATA QUALITY OBJECTIVES AND STOPPING RULES FOR ASBESTOS ANALYSIS BY TEM

1.0 OVERVIEW

The uncertainty around any TEM estimate of asbestos concentration in a sample is a function of the number of structures observed during the analysis. The 90% confidence interval around any observed number of structures is given by the Poisson distribution:

5% lower bound = 0.5 · CHIINV[0.05, 2·N)]
95% upper bound = 0.5 · CHIINV[0.95, 2·N+2]

where:

CHIINV = Inverse chi squared cumulative distribution function
N = Number of structures observed

As N increases, the absolute width of the confidence interval increases, but the relative uncertainty [expressed as the 90% confidence interval (CI) divided by the observed value (N)] decreases, as follows:

N	LB	UB	CI	CI / N
0	0.00	3.00	3.00	+Infinity
1	0.05	4.74	4.69	469%
2	0.36	6.30	5.94	297%
3	0.82	7.75	6.94	231%
5	1.97	10.51	8.54	171%
10	5.43	16.96	11.54	115%
20	13.25	29.06	15.81	79%
50	38.96	63.29	24.32	49%

LB = lower bound; UB = upper bound

For the purposes of this Supplemental RI QAPP, the data quality objective for all samples of air, dust, or soil analyzed by TEM is to achieve a count of N that provides an acceptable level of uncertainty, unless the number of grid openings needed to achieve the target uncertainty is too costly to achieve, or unless the sensitivity achieved is below a negligible level of health concern.

Details on these data quality objectives are presented below for each medium.

2.0 AIR

2.1 Long-Term Exposures

Level of Concern

For air, the relation between lifetime average concentration in air and lifetime excess cancer risk (lung cancer plus mesothelioma) is given by:

$$R = C(air) \cdot \text{Unit Risk}$$

Thus, the long-term average level of concern (LOC) in air is given by:

$$\text{LOC (long-term)} = \text{Target Risk} / \text{Unit Risk}$$

At present, there are two alternative mathematical models available to estimate cancer risk from inhalation exposure to asbestos. The first model (IRIS) expresses asbestos concentration in units of PCM or PCME s/cc, where a PCME structure is > 5 um in length, ≥ 0.25 um in thickness, and has an aspect ratio ≥ 3:1. The IRIS model unit risk for lifetime exposure of a resident is 0.23 per PCME s/cc. Note that this approach does not distinguish between chrysotile and amphibole asbestos. The second model is Berman Crump (2003), which expresses concentration in units of Berman Crump (BC) structures per cc (BC s/cc). A BC structure is ≥ 10 um in length and ≤ 0.4 um in thickness. The Berman Crump model evaluates cancer risk for chrysotile and amphibole separately. The unit risk for lifetime exposure of a resident to amphibole asbestos is 6.28 per BC s/cc.

At the present time, most analyses of air samples at Libby are performed using TEM. Therefore, it is most convenient to express all concentration values in units of TEM s/cc. In this case, the risk-based LOCs (PCME s/cc or BC s/cc) may be converted to units of total TEM s/cc using data on the distribution of LA particle sizes in air at Libby (see Attachment C) as follows:

$$\text{IRIS LOC(TEM s/cc)} = (\text{Target Risk} / \text{IRIS Unit Risk}) / 0.43$$
$$\text{BC LOC(TEM s/cc)} = (\text{Target Risk} / \text{BC Unit Risk}) / 0.041$$

where:

0.43 = Fraction of total TEM structures in air that are PCME structures[3]
0.041 = Fraction of total TEM structures in air that are BC structures

The target risk level is a matter of risk management judgment. For the purposes of these calculations, the target risk level is set at 1E-04. Based on this, the LOC values in air are:

[3] See Attachment C for detailed information on the basis of these fractions.

Risk Model	LOC in Air (s/cc)	
	Risk-Based	TEM-Based
IRIS	4.3E-04 PCME s/cc	1.0 E-03 TEM s/cc
Berman Crump	1.6E-05 BC s/cc	3.9E-04 TEM s/cc

Target Sensitivity

The target sensitivity (expressed as total TEM s/cc) is set to a value such that a count of 10 structures is expected if the true concentration is equal to the level of concern in air. This is equivalent to requiring that the target sensitivity is 1/10 the LOC:

Target Sensitivity in Air for Long-Term Exposure Scenarios

Risk Model	Target Sensitivity (TEM s/cc)
IRIS	1E-04
Berman Crump	4E-05

For convenience, the target sensitivity for long term exposures to air is set at 4E-05 s/cc. If an air sample with a true concentration equal to the target sensitivity were encountered, the expected structure count would be about 1-2, but the risk of asbestos-related cancer at this sensitivity (about 5E-06 to 1E-05) would be sufficiently low that reliable quantification of asbestos levels in air beyond this level of sensitivity does not appear to be necessary.

Estimation of GOs Needed to Achieve Target Sensitivity

The number of TEM grid openings (GOs) needed to achieve a specified target sensitivity may calculated for any given air sample by:

$$GOs = EFA / (TS \cdot Ago \cdot V \cdot 1000 \cdot F)$$

where:

EFA = Effective filter area (usually 385 mm^2)
TS = Target sensitivity
Ago = Area of one grid opening (mm^2) (typically about 0.01 mm^2)
V = Volume of air drawn through the filter (L)
1000 = Conversion factor (cc / L)
F = Fraction of original sample applied to the filter (secondary prep only)

In some cases (especially for samples with a small volume and/or a small F factor), the number of GOs needed to achieve a target sensitivity may be cost-prohibitive. In these cases, the number of GOs may be limited to some specified maximum number (e.g., 100), but it is not desirable to accept a sensitivity that is less than the level of concern.

2.2 Short-Term Exposures

As discussed above, the target sensitivity for air is a function of the LOC in air. For short-term exposures, the LOC is typically higher than for long-term exposures. Exact LOC values depend on the frequency and duration of exposure and also on the age at exposure. However, screening level estimates of the LOC can be obtained simply by multiplying the long-term LOC by the fraction of a lifetime that the short-term scenario represents. For example, if someone were exposed 4 hours per day, 25 days per year, for 30 years, the fraction would be $4/24 \cdot 25/365 \cdot 30/75 = 0.005$.

Because there are a wide variety of short-term exposures that could occur in Libby, a conservative factor of 0.04 is chosen to estimate the upper end of the fraction of a lifetime occupied by a short-term or intermittent exposure scenario. This would correspond, for example, to exposure of about 4 hours per day for 90 days per year. Based on this, the target sensitivity for short-term exposure is 1E-03 TEM s/cc, 25-times higher than the target for long-term exposure scenarios.

2.3 Summary: Stopping Rules for Air

In summary, the TEM stopping rules for air samples analyzed by TEM under this Supplemental RI QAPP are:

Always count at least 5 GOs
Once 5 GOs are counted, continue counting GOs until one of the following is satisfied:

- The total number of structures counted exceeds 50
- The total filter area examined reaches 1 mm^2. For a grid with grid openings of 0.01 mm^2, this corresponds to a maximum of 100 GOs counted.
- The sensitivity achieved is less than 4E-05 s/cc (long-term exposure scenarios) or 1E-03 s/cc (short-term exposure scenarios)

3.0 DUST

Level of Concern

For indoor dust, the level of concern depends on how much of the dust gets into air where it can be breathed. The release of asbestos from dust to air is characterized by a K-factor, as follows:

$$C(air) = Kda \cdot C(dust)$$

Because the amount of asbestos in dust is usually expressed as s/cm^2, the units of Kda are s/cc per s/cm^2 (1/cm).

Given Kda, the LOC in dust is calculated as:

$$LOC\ (dust) = (Target\ Risk\ /\ Unit\ Risk)\ /\ Kda$$

Data on the value of Kda are limited, but based on studies at other locations, a screening level value of about 4E-06 s/cc per s/cm^2 seems reasonable (EPA 2003). Assuming the same target risk and same unit risk values as described above, and using data on the distribution of LA particles in dust available from Libby (see Attachment C), the LOC values for dust are:

Risk Model	LOC in Dust(s/cm^2)	
	Risk-based	TEM
IRIS	109 PCME s/cm^2	561 TEM s/cm^2
Berman Crump	4.0 BC s/cm^2	217 TEM s/cm^2

Target Sensitivity

As above, the target sensitivity (expressed as TEM s/cm^2) is set to a value smaller than the LOC (expressed as TEM s/cm^2) to ensure that, if a sample at the LOC were encountered, a sufficient number of structures would be counted to ensure the uncertainty bound around the count would not be too wide. For the purposes of this assessment, it is assumed that the minimum number of structures required to achieve acceptable uncertainty bounds is a count of 10. That is, the target sensitivity is 1/10 the LOC:

Target Sensitivity for Dust

Risk Model	Target Sensitivity (TEM s/cm^2)
IRIS	56
Berman Crump	22

For simplicity, the target sensitivity for dust is set to 20 TEM s/cm^2. If a sample at the LOC were encountered, a structure count of about 10-25 would be expected. If a sample at the target sensitivity were encountered, the expected count would be about 1-2 structures, but the risk of asbestos-related cancer at this sensitivity (4E-06 to 1E-05) is sufficiently low that reliable quantification of asbestos levels beyond this level of sensitivity does not appear to be necessary.

Estimation of GOs Needed to Achieve Target Sensitivity

The number of TEM GO's needed to achieve a specified target sensitivity for dust may calculated for any given sample by:

$$GOs = EFA / (TS \cdot Ago \cdot A \cdot F)$$

where:

EFA = Effective filter area (usually 1295 mm^2)
TS = Target sensitivity
Ago = Area of one grid opening (mm^2) (typically about 0.01 mm^2)
A = Area of surface vacuumed to collect dust sample (typically 300 cm^2)
F = Fraction of original sample applied to the filter (typically 0.1)

As noted above, in some cases (especially for samples with a small area and/or a small F factor), the number of GOs needed to achieve a target sensitivity may be cost-prohibitive. In these cases, the number of GOs may be limited to some specified maximum number (e.g., 100), but it is not desirable to accept a sensitivity that is less than the level of concern.

Summary: Stopping Rules for Dust

In summary, the TEM stopping rules for dust samples analyzed by TEM under this Supplemental RI QAPP are:

- Always count at least 5 GOs
- Once 5 GOs are counted, continue counting GOs until one of the following is satisfied:
    - The total number of structures counted exceeds 50
    - The total filter area examined reaches 1 mm^2. For a grid with grid openings of 0.01 mm^2, this corresponds to a maximum of 100 GOs counted.
    - The sensitivity achieved is less than 20 TEM s/cm^2

4.0 SOIL

Level of Concern

For outdoor soil, screening level calculations suggest that the exposure pathway most likely to be important to residents is transport of soil into indoor locations where the soil becomes part of the indoor dust (EPA 2003). As discussed above, the contribution of asbestos in soil to asbestos in indoor dust is characterized by Ksd:

$$C(\text{dust})\ (\text{s/cm}^2) = \text{Ksd}\ (\text{g soil/cm}^2) \cdot C(\text{soil})\ (\text{s/g soil})$$

Given Ksd, the LOC in soil is calculated as:

$$\text{LOC (soil)} = (\text{Target Risk / Unit Risk}) / (\text{Kda} \cdot \text{Ksd})$$

Data on the value of Ksd are limited, but a screening level value of about 3E-05 g soil/cm^2 can be derived from the screening level estimates of ksd (mass fraction of soil in dust) and L (dust loading on surfaces) employed by EPA (2003), as follows:

$$\text{Ksd} = \text{ksd} \cdot \text{L} = 0.3\ \text{g soil / g dust} \cdot 1\text{E-04 g dust/cm}^2 = 3\text{E-05 g soil/cm}^2$$

Based on this estimate for Ksd, and assuming a Kda value of 4E-06 s/cc per s/cm^2 (see above) and assuming the same target risk and same unit risk values as described above, the LOC values for soil are:

Risk-Based LOC in Soil

Risk Model	LOC (TEM s/g)
IRIS	1.9E+07 TEM s/g
Berman Crump	7.3E+06 TEM s/g

However, analysis of soil by TEM does not yield a direct measure of TEM s/g soil. Rather, the soil analysis yields a measure of the asbestos mass fraction (grams of asbestos per gram soil). Assuming that asbestos particles in soil have the same particle size distribution as particles in dust, the following equation is used to estimate TEM s/g soil from the TEM-based mass fraction:

TEM s/g soil = (g asbestos / g soil) · (TEM s / g asbestos)

Based on available data from TEM structures observed in dust at the Libby site (see Attachment C), the number of TEM structures per gram asbestos is about 2.5E+11. Based on this, the estimated LOC values expressed as mass fraction (percent of soil that is asbestos) are as follows:

Mass Fraction-Based LOC in Soil

Risk Model	LOC (% by mass in soil)
IRIS	0.008%
Berman Crump	0.003%

Target Sensitivity

As above, the target sensitivity (expressed as % mass fraction) is set to a value smaller than the LOC to ensure that, if a sample at the LOC were encountered, a sufficient number of structures would be counted to ensure the uncertainty bound around the count would not be too wide. For the purposes of this assessment, it is assumed that minimum structure count of 10 is required to limit uncertainty to an acceptable level. That is, the target sensitivity is 1/10 the LOC:

Risk Model	Target Sensitivity (% by mass in soil)
IRIS	0.0008%
Berman Crump	0.0003%

For simplicity, the target sensitivity for soil is set to 0.0003%. If a soil sample at the LOC were encountered, this sensitivity would yield an expected count of about 10. If a sample at the target sensitivity were encountered, the expected count would be about 1, but the computed asbestos-related cancer risk at this sensitivity (4E-06 to 1E-05) is sufficiently low that reliable quantification of asbestos levels in soil beyond this level of sensitivity does not appear to be necessary.

Estimation of GOs Needed to Achieve Target Sensitivity

The number of TEM GO's needed to achieve a specified target sensitivity for soil (expressed as a percentage) may calculated for any given sample by:

$$GOs = 100 \cdot EFA / (TS \cdot m_s \cdot Ago \cdot spg)$$

where:

EFA = Effective filter area (usually 1295 mm^2)
TS = Target sensitivity (percent)
m = mass of soil applied to the filter (g) (typically 1E-03 g)
Ago = Area of one grid opening (mm^2) (typically about 0.01 mm^2)
spg = structures per gram of asbestos (2.5E+11)

Based on these typical values, the number of GOs required to achieve a sensitivity of 0.0003% is about 170. Because analysis of this number of GOs may be cost-prohibitive, the number of GOs may be limited to some specified maximum number (e.g., 100).

Summary: Stopping Rules for Soil

In summary, the TEM stopping rules for soil samples analyzed by TEM under this Supplemental RI QAPP are:

- Always count at least 5 GOs
- Once 5 GOs are counted, continue counting GOs until one of the following is satisfied:
    - The total number of structures counted exceeds 50
    - The total filter area examined reaches 1 mm^2. For a grid with grid openings of 0.01 mm^2, this corresponds to a maximum of 100 GOs counted.
    - The sensitivity achieved is less than 0.0003% (about 250,000 s/g soil)

NOTE ON THE PRACICABILITY OF ACHIEVING TARGETS IN SOIL

Because of small scale heterogeneity in soil samples, current analytical methods are not available to allow reliable quantification of asbestos in soil at the target sensitivity level identified above. Until methods are improved, analysis of soil for low levels of asbestos will remain problematic.

ATTACHMENT C

ESTIMATION OF LA PARTICLE PROPERTIES NEEDED FOR RISK-BASED CALCULATIONS

1.0 INTRODUCTION

As discussed in Attachment B (above), estimation of the levels of cancer concern and selection of target analytical sensitivities for Libby amphibole (LA) particles in air, dust, and soil at the Libby Superfund site depends on knowledge of five key properties of LA structures, including:

- The fraction of all countable LA structures in air that are PCME structures
- The fraction of all countable LA structures in air that are BC structures
- The fraction of all countable LA structures in dust that are PCME structures
- The fraction of all countable LA structures in dust that are BC structures
- The number of countable structures per gram of asbestos in dust

For convenience, the first four factors are collectively referred to as “risk fractions”, since they each describe the fraction of total TEM structures in a medium (air or dust) that have the proper characteristics to be used in either the IRIS risk model (PCME structures) or the Berman-Crump risk model (BC structures). The fifth factor (structures per gram asbestos) is the reciprocal of the average mass of a single asbestos structure.

All of these factors can be derived from data on the size distribution of LA particles in air and dust at the Libby site. Because two different counting methods (ISO 10312 and AHERA) have been used for analyzing air and dust samples at the Libby site, the data were reviewed to determine whether the data used to calculate these factors should be based on ISO, AHERA, or the combination. *A priori*, it is expected that there should be little difference between the data based on the ISO method and data based on the AHERA method. This is because the primary difference between these two methods is in the counting rules for diffuse bundles and clusters, and only a small fraction of all LA structures in air and dust occur in these forms. Thus, the default presumption is that the combined data set is likely to be preferred because use of the combined data increases the number of structures used in the calculations and reduced uncertainty in the computed factors.

2.0 DATA EVALUATION

Data used in this evaluation were obtained from a download of TEM data from the Libby 2 database on 12/27/2004. All countable LA structures ≥ 0.5 um in length observed in air or dust field samples (not including QC samples) collected at the Libby site were used in the evaluation.

2.1 Risk Fractions

The following table summarizes the risk fractions calculated for air and dust, keeping the data from ISO and AHERA separate:

Risk Fractions in Air and Dust Stratified by Analytical Method

Statistic	Air Samples				Dust Samples			
	ISO	AHERA	Ratio	p Value	ISO	AHERA	Ratio	p Value
Total Number of Structures	4,188	3,249			1,296	500		
Number of PCME Structures	1,417	1,782			225	123		
Number of BC Structures	144	159			19	14		
Fraction PCME	0.34	0.55	1.6	< 0.001	0.17	0.25	1.5	0.002
Fraction BC	0.034	0.049	1.4	0.002	0.015	0.028	1.9	0.062

As seen, the risk fractions for both air and dust tend to be higher (by about a factor of 1.4 to 1.9) for AHERA-based data than ISO-based data, and most differences are statistically significant.

One potential reason for this difference is that, at the Libby site, the counting rules for ISO have been modified to include structures with an aspect ratio of ≥ 3:1, while AHERA counting rules only include structures with an aspect ratio of ≥ 5:1. However, when all ISO structures with aspect ratio < 5:1 were excluded, the difference in risk ratios was approximately unchanged. A potential alternative explanation for the difference is that, because ISO was used mainly early in the Libby investigation and AHERA analysis has been used more recently, there could be some sort of systematic difference in the types of samples analyzed by ISO and AHERA. In order to test this idea, several different methods for grouping the data were tested, including stratification by type of location (mining-related *vs* residential/commercial), location (indoor *v*s outdoor), and sampling date. Although the values of the risk fractions varied as a function of the data stratification approach, the ratio of the fractions (AHERA compared to ISO) usually remained greater than 1.0, and typically remained in the same range (1.3 to 1.7) as in the un-stratified data. The difference was even present in a data set of structures from samples that were each analyzed by both ISO and AHERA. Thus, the basis of the unexpected difference is not known.

Several alternative strategies were considered for dealing with this issue. After discussion, it was decided that the best approach, at least at present, is to use the combined data sets (ISO plus AHERA) to calculate the risk fractions for air and dust. The advantages of this approach are:

- All of the data are used, increasing the number of observations used in the calculations, which in turn helps to decrease statistical uncertainty.
- Because the basis for the difference is not known, it is unclear if either one data set or the other is more likely to be correct. Hence, using the combination of the two minimizes the magnitude of any potential bias in the computed values.
- Application of the results to calculate risks and levels of concern are not specific to the analytical method used to generate data. If the factors were stratified by analytical method, then different risks would result at two locations where concentrations were equal but the analytical methods were different.

The results of the calculations based on this approach are summarized below:

Risk Fractions in Air and Dust (Combined ISO and AHERA Data Sets)

Statistic	Medium	
	Air	Dust
Total Number of Structures	7,437	1,796
Number of PCME Structures	3,199	348
Number of BC Structures	303	33
Fraction PCME	0.43	0.19
Fraction BC	0.041	0.018

2.2 Mean Particle Size

Two approaches are available for estimating the mean mass per structure. The most direct approach is simply to calculate the mass of each structure and find the average (mean) value. However, this approach is quite sensitive to the effect of a few very large particles that can shift the average by several fold or more. For example, based on a set of 1296 ISO LA particles in dust, the average mass of one structure is 1.4E-11 g. If the three largest structures out of the 1296 structures total are excluded, the average mass decreases to 5.7E-12, nearly a factor of 2.5-fold. This high sensitivity of the result on the presence of just a few structures (0.2% of the total) is not considered desirable, so an alternative approach was used. In this approach, the data were fit to a lognormal distribution to obtain an estimate of the geometric mean (GM) and the geometric standard deviation (GSD). The arithmetic mean was then calculated from the GM and GSD as follows:

$$\text{mean} = \exp[\ln(GM) + 0.5 \cdot \ln(GSD)^2]$$

The results of this method are shown below:

Estimation of Average Particle Mass (g)

Statistic	ISO	AHERA	Combined
Number of structures	1296	500	1796
Observed mean (g)	1.4E-11	4.8E-12	1.2E-11
Best fit GM (g)	7.1E-13	8.4E-13	7.3E-13
Best Fit GSD	6.5	5.9	6.3
Calculated mean (g)	4.0E-12	4.1E-12	4.0E-12
Structures per gram	2.5E+11	2.5E+11	2.5E+11

As seen, this approach yielded estimates of the average particle mass and of structures per gram that did not depend on which method (ISO or AHERA) was used to generate the raw data.

3.0 SUMMARY OF FACTORS

Based on the approaches and the data discussed above, the factors selected for use in calculations of levels of concern and target sensitivity (see Attachment B) are as follows:

Medium	Factor	Value
Air	Risk fraction (PCME / total)	0.43
	Risk fraction (BC / total)	0.041
Dust	Risk fraction (PCME / total)	0.19
	Risk fraction (BC / total)	0.018
	Structures / gram asbestos	2.5E+11

These factors may be revised in the future as more site data are accumulated.

ATTACHMENT D

FIELD DATA SHEET FOR SCENARIO SAMPLING

LIBBY SUPERFUND SITE

FIELD DATA SHEET FOR SCENARIO SAMPLING

Date:____________________

Field Team Leader:___________________

Location:____

Scenario Type:____

List of samples collected:

	Sample Number	Notes
Personal air:	_______________________	______________________________
	_______________________	______________________________
	_______________________	______________________________
Upwind air:	_______________________	______________________________
Downwind air:	_______________________	______________________________
Soil:	_______________________	______________________________
	_______________________	______________________________

Site Conditions:

Weather:____

Meteorological Recorder:____

Soil Condition:____

Other:____

Videotape ? Yes:_______________________________________

No

Field Sketch (over): Show scenario location relative to local features. Indicate wind direction.

ATTACHMENT E

TEM COUNTING RULES

ATTACHMENT E

TEM COUNTING RULES

All TEM analyses of air or dist samples for asbestos will be conducted in basic accord with the method and counting rules specified in ISO 10312 and all appropriated project-specific laboratory modification forms, in particular LB-000045. A brief summary of the counting rule changes outlined in LB-000045 are noted below:

1. All asbestos structures with a length greater than or equal to 0.5 um and an aspect ratio of 3:1 or greater shall be recorded.
2. The mineral type of each structure shall be classified as Libby Amphibole (LA), Other Amphibole (OA) or Chrysotile (C). When OA is selected, the mineral type is noted in the comments section.
3. Stopping rules for TEM analysis of LA structures in air and dust samples are specified in Attachment B. If a sample that is rich in chrysotile is encountered, recording of chrysotile structures may be stopped after completing the GO in which the 20^{th} chrysotile structure is observed.

ATTACHMENT F

SUPPORTING DOCUMENTS

(see Excel spreadsheet "Attachment F.xls")

Addendum Submitted for:
ERT PORTION OF SUPPLEMENTAL REMEDIAL INVESTIGATION QUALITY ASSURANCE PROJECT PLAN FOR LIBBY, MONTANA

Approval Signatures:

For Brian Brass
Title: ERT Field Manager
Date 6/29/05

Jim Christiansen
Title: EPA RPM
Date 6/29/05

The following provides additional detail and clarification to the Supplemental RI QAPP.

Task 2

Duplicates are for soils only. Do not collect duplicates for this task.

Collect 1 air field blank per sampling team per day. Collect: 1 microvacuum dust field blank per team per day. Submit for analysis 1 air field blank and 1 microvacuum dust field blank per sampling team per week. Archive the remaining field blanks.

Determine the 8-hour average Libby Amphibole (LA) concentration in indoor air and settle dust in **12** homes. Plan on sampling in a maximum of 3 homes per day.

Area Samples
Collect air samples over an 8-hour period using a stationary air monitor (Aircon) in the main living area of the home. Collect samples at a flow rate of 10 liters per minute for 480 minutes for a total volume of 4800 liters. All data will be documented in field logbooks and Field Sample Data Sheet (FSDS) forms in accord with CDM SOPs. The actual volume collected will be noted on the Chain Of Custody (COC) form so that

analytical laboratories achieve SQAPP-specified analytical sensitivities. Samples shall be collected using 0.8 micron 25 mm Mixed Cellulose Ester (MCE) cassettes, open faced with the inlet facing downward. Stationary air samples will be collected and sampling pumps calibrated using ERT SOP 2015 Asbestos Sampling.

1 sample per home * 3 homes = 3 Aircons/day

Personal/Resident Samples
Collect personnel personal (resident) air samples over an 8-hour period using semi-high volume personal air sample (QuickTake30). Collect samples at a flow rate of 10 liters per minute for 480 minutes for a total volume of 4800 liters. All data will be documented in field logbooks and FSDS forms in accord with CDM SOPs. The actual volume collected will be noted on the COC form so that analytical laboratories achieve SQAPP-specified analytical sensitivities. Samples shall be collected using 0.8 micron 25 mm Mixed Cellulose Ester (MCE) cassettes, open faced with the inlet facing downward at the following personal breathing zone height: 4-6 feet. Personal air samples will be collected and sampling pumps calibrated using ERT SOP 2015 Asbestos Sampling. Residents will provide general information regarding the activities they performed during the sampling period.

1 sample per home * 3 homes = 3 Quick Take 30

Microvacuum Dust Samples
Collect micro-vacuum composite dust from approximately three 100-cm^2 template areas located in the main living space of the house in accord with the standard American Society for Testing and Materials (ASTM) approach (ASTM Method D-5755-95).

Use 0.45 micron 37 mm MCE filter cassettes with the pumps calibrated to 2 liters per minute, vacuum each template area for 2 minutes. Sampling pumps will be calibrated using ERT SOP 2015 Asbestos Sampling.

2 samples per home consisting of three 100-cm2 template composites * 3 homes =6 samples.

High Volume Vacuum Dust Samples

A high volume dust vacuum will be used to collect a composite dust sample from the same main living areas of the home. The mass of dust must be large enough (1-2 grams) that it can be weighed with reasonable precision (±10 mg). The area vacuumed (cm^2) must also be measured with good accuracy so that dust loading (mg/cm^2) can be reliably calculated. The SOP for collection of dust using the high-volume vacuum device is presented in Attachment A-2 of the Supplemental QAPP.

1 sample per home * 3 homes/day = 3 samples

Area Dust Monitoring (DATARAM)
Measure dust levels using a real-time dust monitor (DATARAM). Determine the 8-hour average total dust concentration in air (mg/m^3) in the main living area of the home under normal living activities. The detection limit for the RAM must be 1 ug/m^3 or less.

2 locations/home * 3 home = 6 data rams

Personal/Resident Dust Monitoring (PersonalRAM)
Measure airborne dust with a PersonalRAM secured in the breathing zone of the resident. Indicate where the Personal RAM is placed on the person. Collect data for an 8-hour period.

1 resident/home * 3 homes/day = 3 Personal Rams

Task 3b Scenario Sampling

Collect 1 activity-based field blank per scenario. Approximately 10% of the total number of field blanks collected for a scenario activity will be analyzed and the remaining archived. The fraction of field blanks selected for analysis shall range over the length of the project and over expected soil concentration ranges. All air field blanks shall be processed for analysis by direct preparation.

The following decision point will be followed when determining which of 2 samples collected will be submitted for analysis. The sample that is not submitted for analysis will be archived.

Field Level Decision Point:

> If the high volume sample appears readable (not overloaded), it will be submitted for analysis using a direct preparation and the low volume sample will be archived. If the high volume sample appears un-readable (overloaded), the high volume sample will be submitted for analysis using indirect preparation <u>and</u> the low volume sample will be submitted for analysis using a direct preparation for comparison. Collecting the extra sample involves only minor effort and costs when compared to losing the data from the whole scenario.

Child Playing in the Dirt
Two pumps (QuickTake 30 & SKC), 10 and 3.5 liters per minute for 120 minutes (1200 and 420 liter volume, respectively). Sample at child's height (approximately 2 feet). Samples shall be collected using 0.8 micron 25 mm Mixed Cellulose Ester (MCE) cassettes, open faced with the inlet facing downward. Activity-based scenario samples will be collected and sampling pumps calibrated using ERT SOP 2015 Asbestos Sampling. All data will be documented in field logbooks and FSDS forms in accord with CDM SOPs. The actual volume collected will be noted on the COC form so that analytical laboratories achieve SQAPP-specified analytical sensitivities.

Collect 1 upwind (within 20 to 40 feet of activity) and 1 downwind (within 10 feet) air sample at a flow rate of 10 liters/minute for 120 minutes for a total volume of 1200 liters. Samples shall be collected using 0.8 micron 25 mm Mixed Cellulose Ester (MCE) cassettes, open faced with the inlet facing downward. Stationary air samples will be collected and sampling pumps calibrated using ERT SOP 2015 Asbestos Sampling. All data will be documented in field logbooks and FSDS forms in accord with CDM SOPs. The actual volume collected will be noted on the COC form so that analytical laboratories achieve SQAPP-specified analytical sensitivities.

DataRAM: 1 upwind and 1 downwind to measure total particulate. Particulate concentrations will be recorded over the same time period as the upwind and downwind stationary air samples.

Raking of Soil
Two pumps (QuickTake 30 & SKC), 10 and 3.5 liters per minute for 120 minutes (1200 and 420 liter volume). Sample at adult height (approximately 4-6 feet). Samples shall be collected using 0.8 micron 25 mm Mixed Cellulose Ester (MCE) cassettes, open faced with the inlet facing downward. Activity-based scenario samples will be collected and sampling pumps calibrated using ERT SOP 2015 Asbestos Sampling. All data will be documented in field logbooks and FSDS forms in accord with CDM SOPs. The actual volume collected will be noted on the COC form so that analytical laboratories achieve SQAPP-specified analytical sensitivities.

Collect 1 upwind and 1 downwind air sample at a flow rate of 10 liters/minute for 120 minutes for a total volume of 1200 liters. Samples shall be collected using 0.8 micron 25 mm Mixed Cellulose Ester (MCE) cassettes, open faced with the inlet facing downward. Stationary air samples will be collected and sampling pumps calibrated using ERT SOP 2015 Asbestos Sampling. All data will be documented in field logbooks and FSDS forms in accord with CDM SOPs. The actual volume collected will be noted on the COC form so that analytical laboratories achieve SQAPP-specified analytical sensitivities.

DataRAM: 1 upwind and 1 downwind to measure total particulate. Particulate concentrations will be recorded over the same time period as the upwind and downwind stationary air samples.

Lawn Mowing
Four pumps (QuickTake 30 & SKC), 10 and 3.5 liters per minute for 120 minutes (1200 and 420 liter volume). Sample at adult height for 2 of the samples (4-6 feet) and at a child's height (early teens-about 3.5-4.5 feet) for one of the high volume samples and one of the low. Samples shall be collected using 0.8 micron 25 mm Mixed Cellulose Ester (MCE) cassettes, open faced with the inlet facing downward. Activity-based scenario

samples will be collected and sampling pumps calibrated using ERT SOP 2015 Asbestos Sampling. All data will be documented in field logbooks and FSDS forms in accord with CDM SOPs. The actual volume collected will be noted on the COC form so that analytical laboratories achieve SQAPP-specified analytical sensitivities.

Collect 1 upwind and 1 downwind air sample at a flow rate of 10 liters/minute for 120 minutes for a total volume of 1200 liters. Samples shall be collected using 0.8 micron 25 mm Mixed Cellulose Ester (MCE) cassettes, open faced with the inlet facing downward. Stationary air samples will be collected and sampling pumps calibrated using ERT SOP 2015 Asbestos Sampling. All data will be documented in field logbooks and FSDS forms in accord with CDM SOPs. The actual volume collected will be noted on the COC form so that analytical laboratories achieve SQAPP-specified analytical sensitivities.

DataRAM: 1 upwind and 1 downwind to measure total particulate. Particulate concentrations will be recorded over the same time period as the upwind and downwind stationary air samples.